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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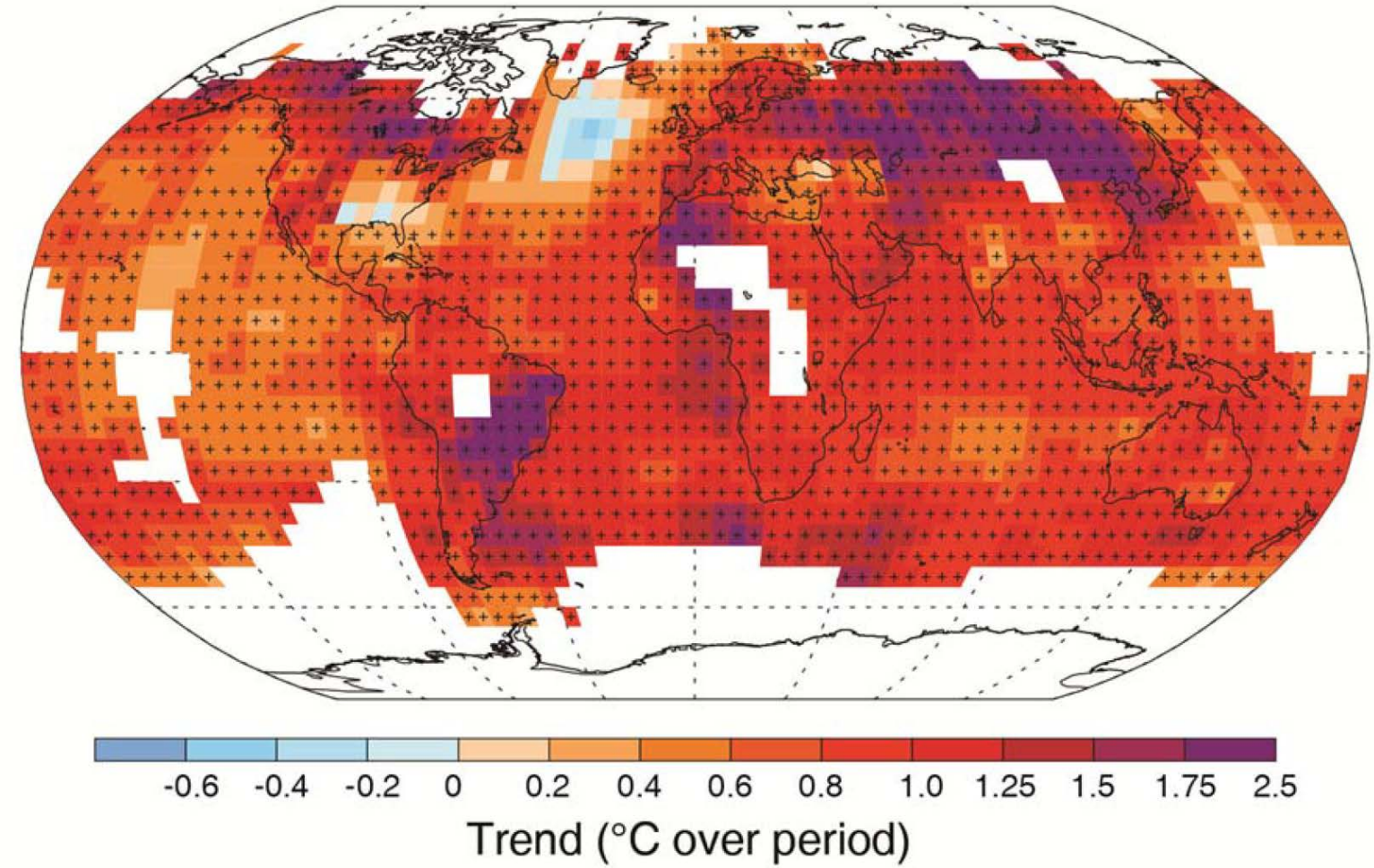
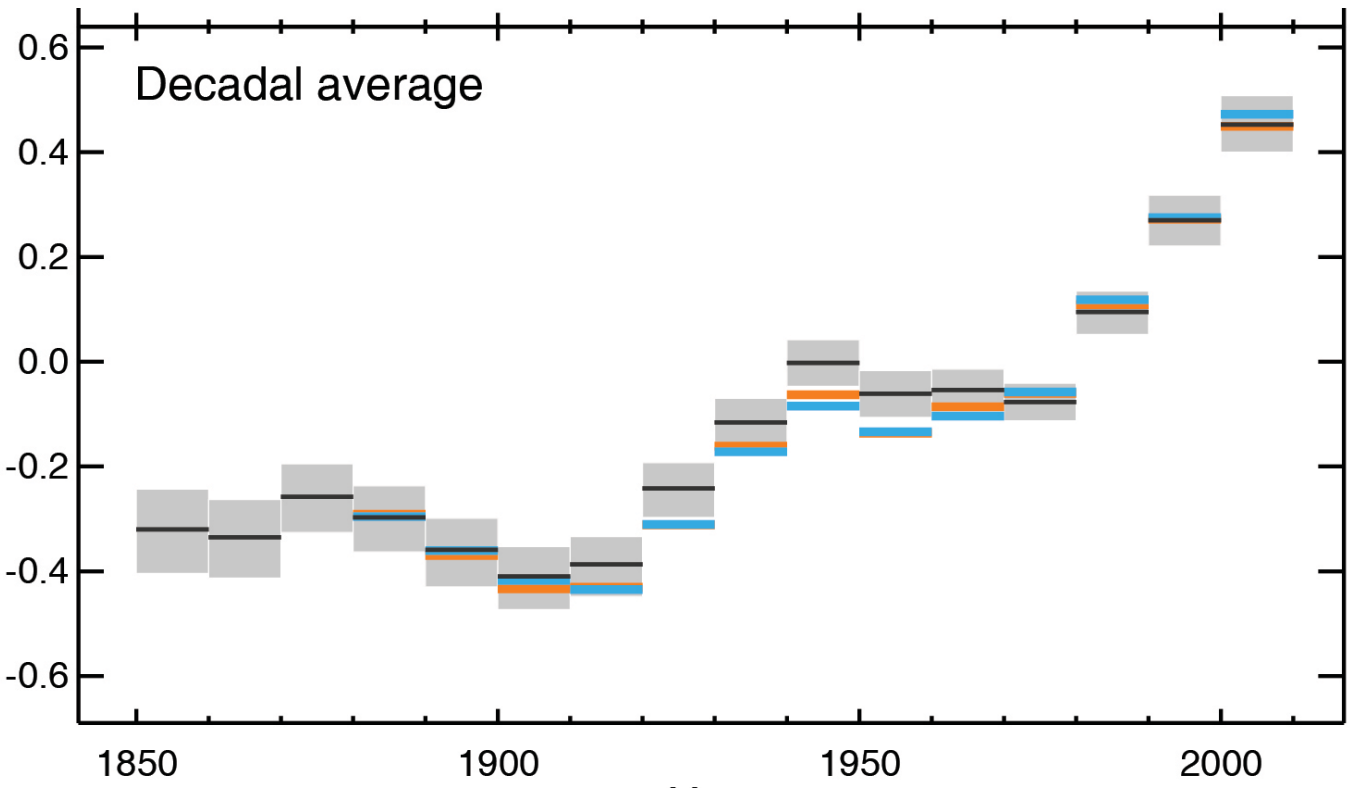
Outline

- Background science to global warming
- Trends in emissions with implications
- Implications for extremes:
  - Heatwaves, floods, cyclones, hail etc
- Implications for emissions and depth of cuts required



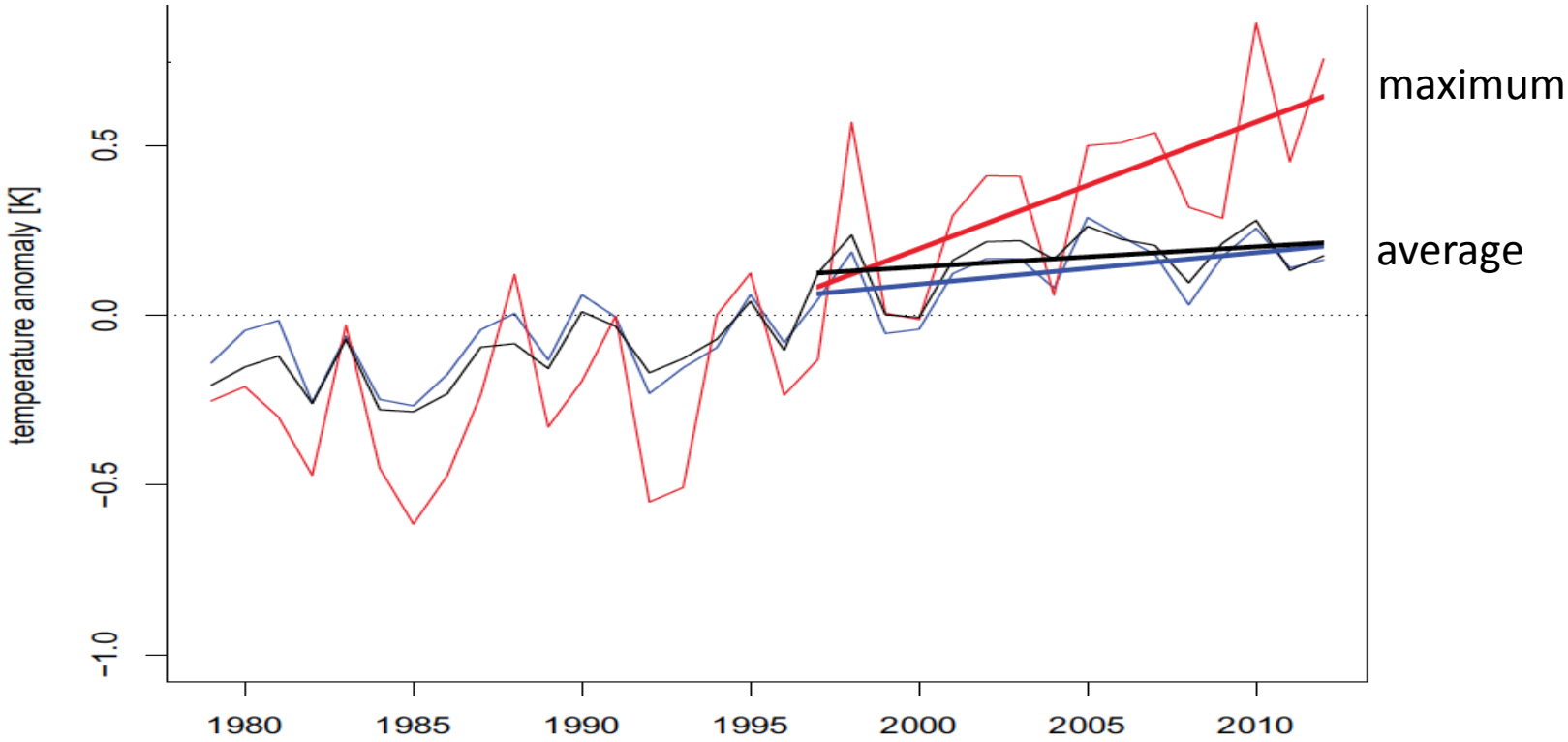
Warming in the climate system is unequivocal

Global temperatures are rising …



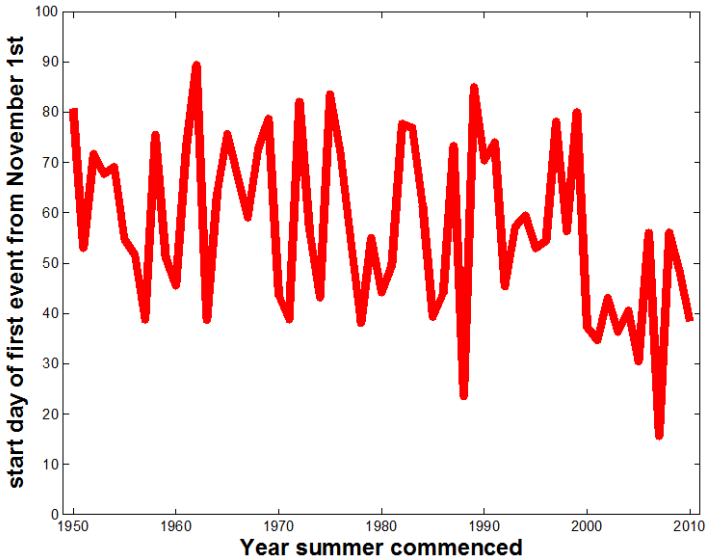
Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850.

Temperature extremes are rising …

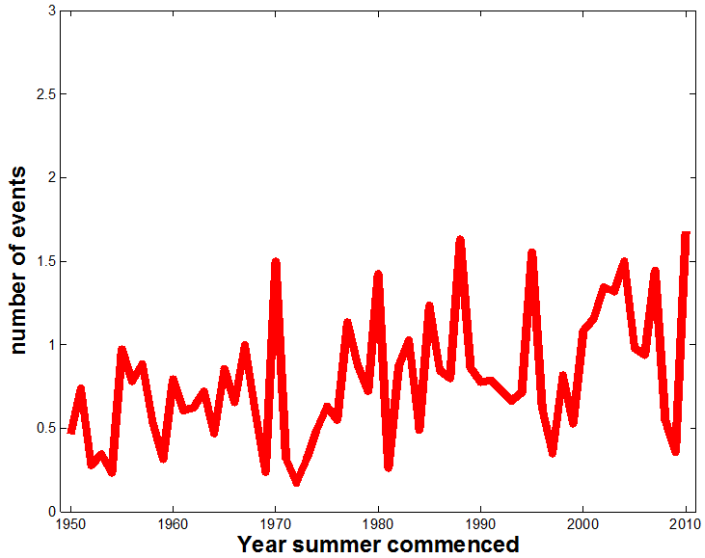


Seneviratne, Nature Climate Change, 2014

Australian heatwaves



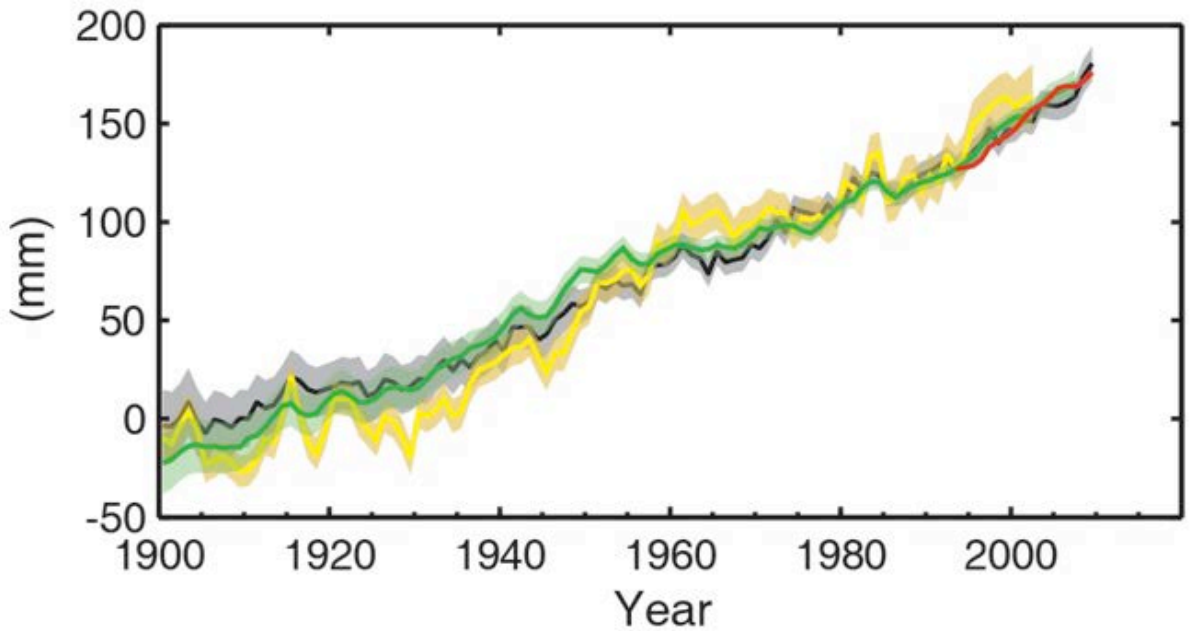
Heat waves are also getting earlier …



Heat waves are getting longer, earlier and more intense

Perkins and Alexander, 2013, Journal of Climate

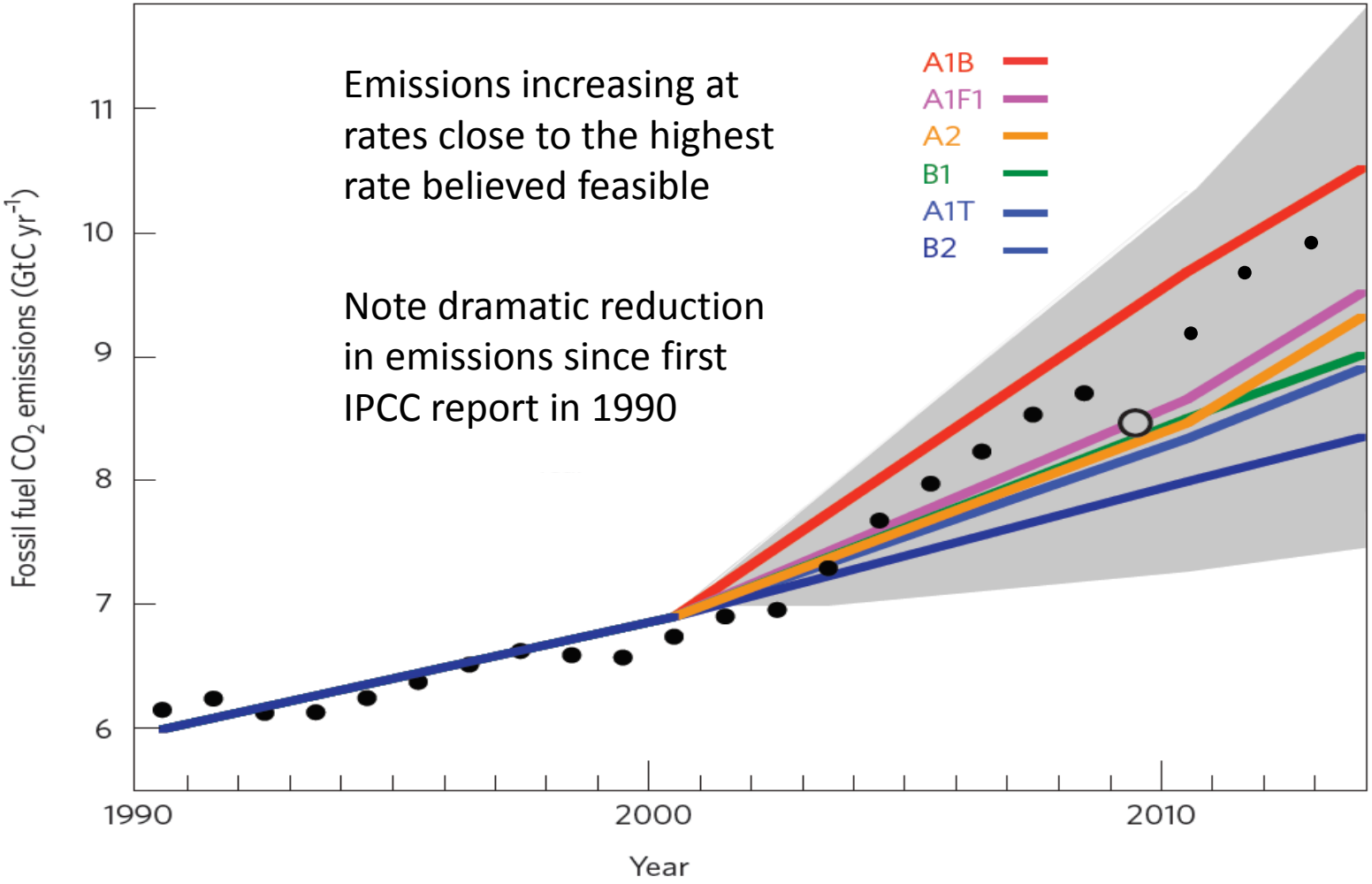
We know sea level is rising



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

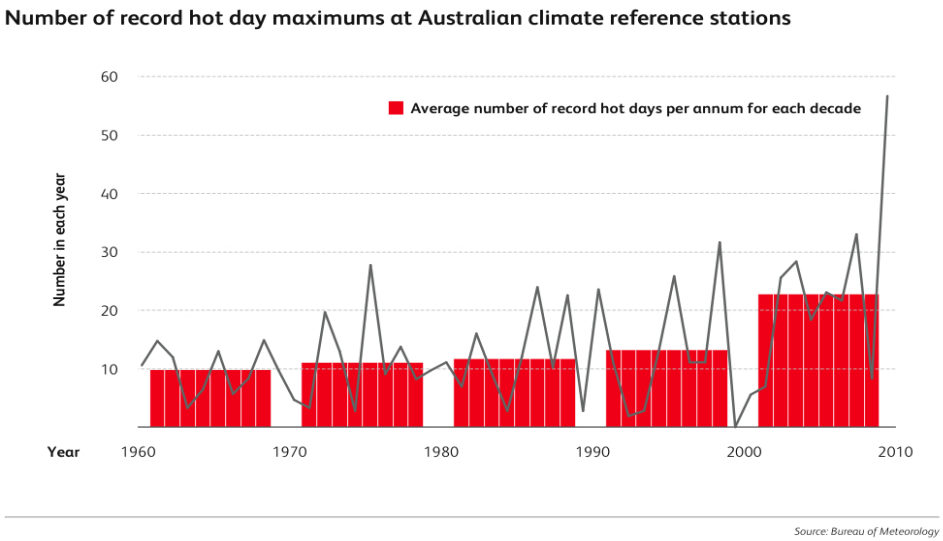
The recent rate of sea level rise is unusual in the context of the last 2000 years.

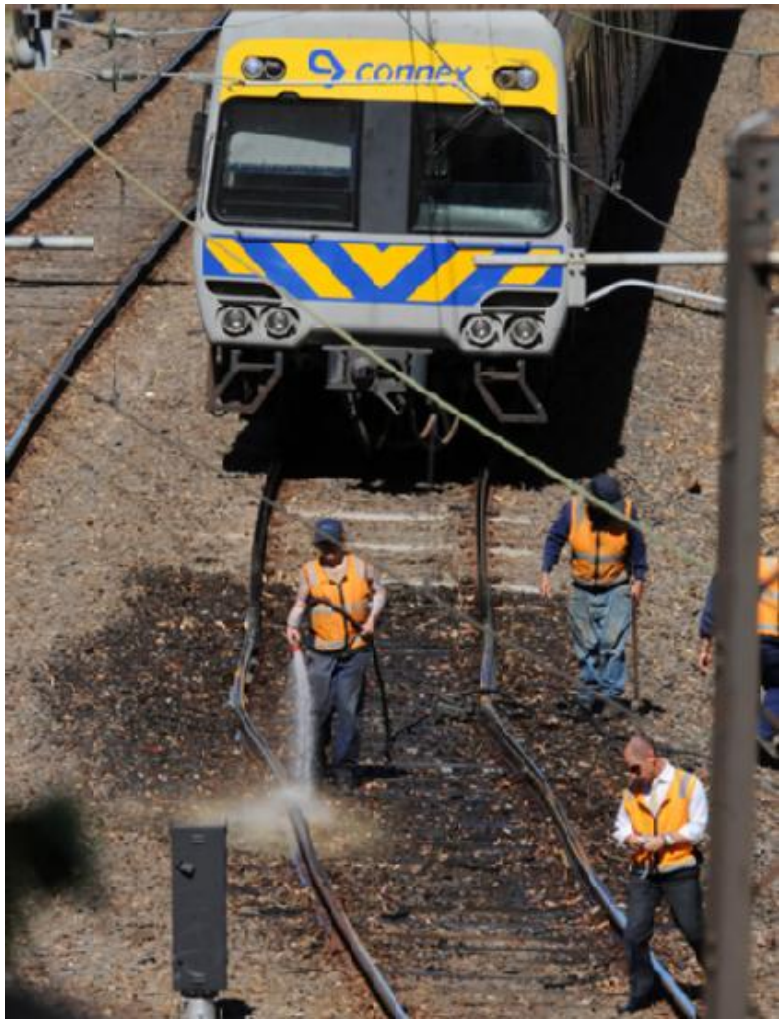
We know emissions are increasing



Note – emissions higher than A1FI

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

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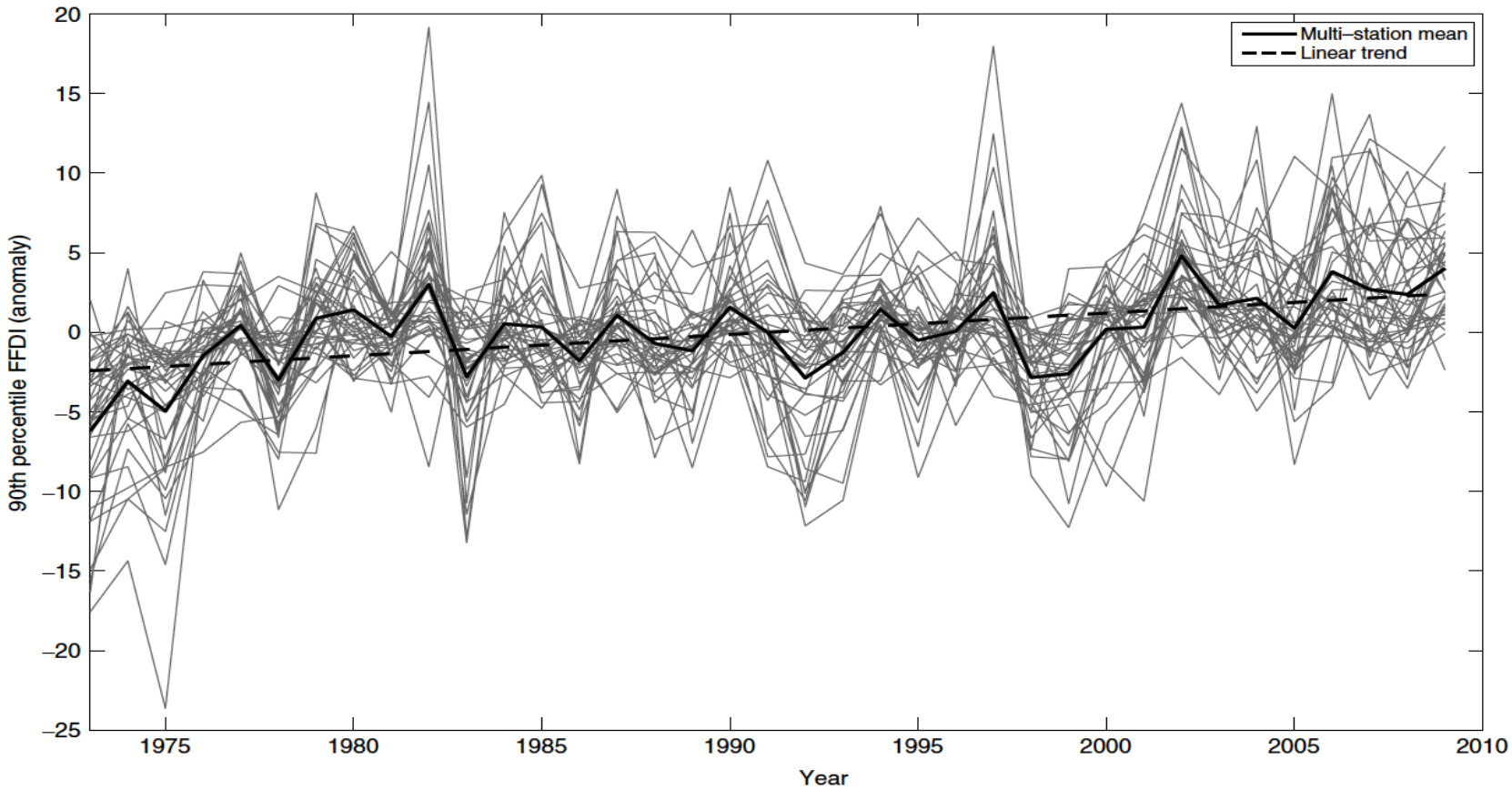
Other extremes: bush fires

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



Clarke et al., 10.1002/joc.3480

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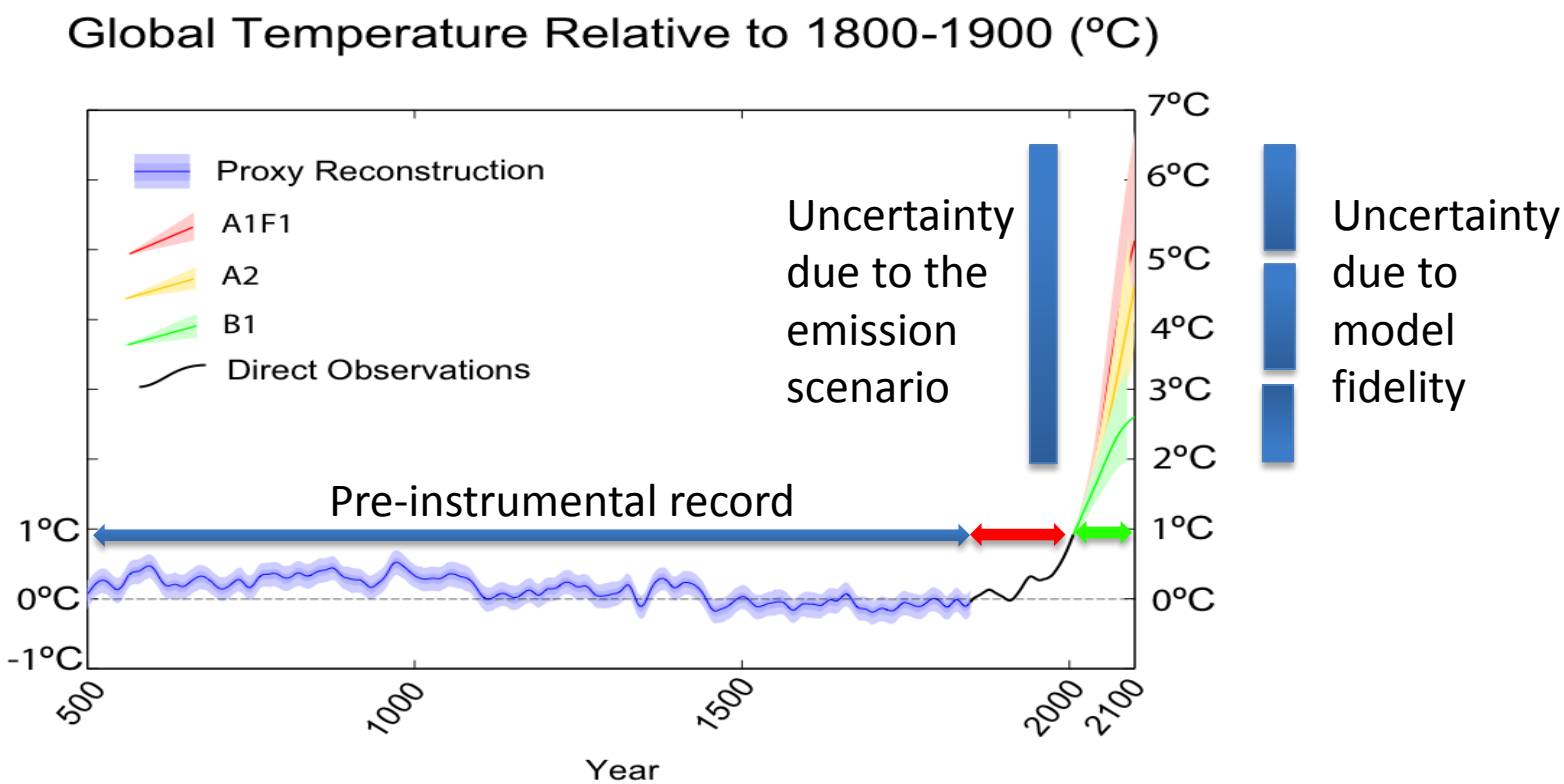
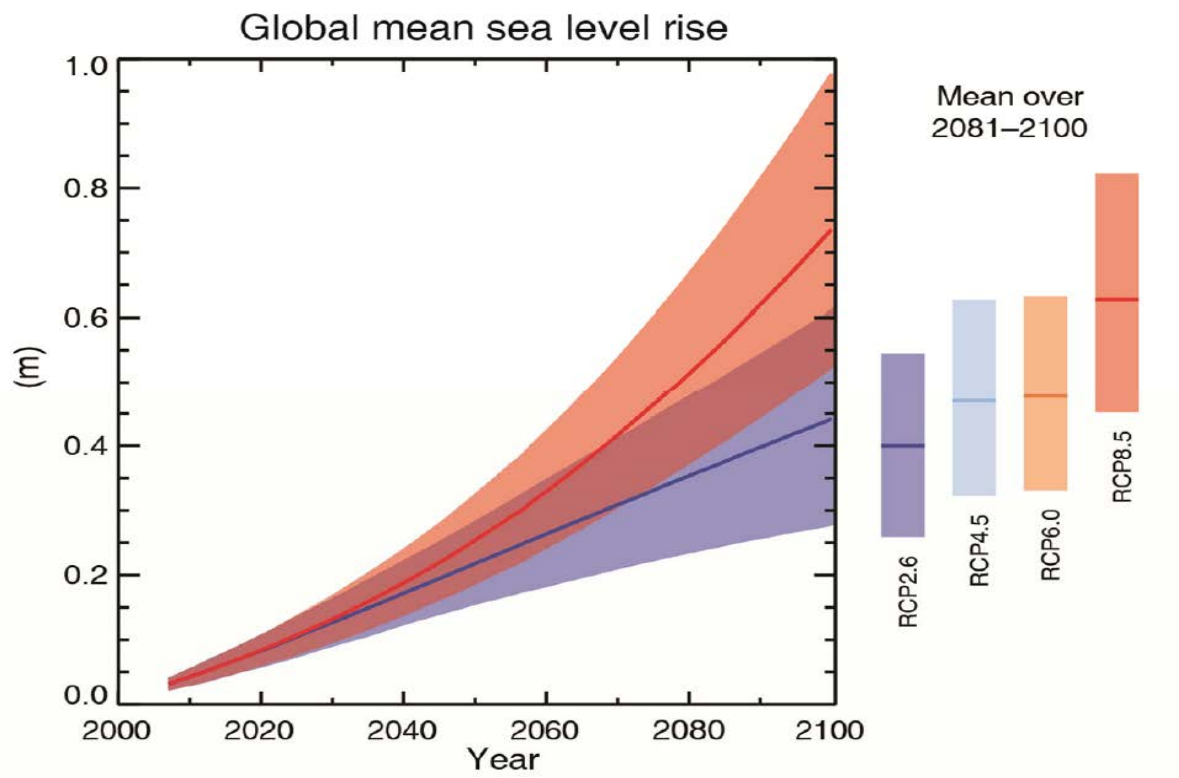
Future warming

- Simulating future trends is a matter of emissions



- Remember – current emissions higher than A1F1

Sea level rise

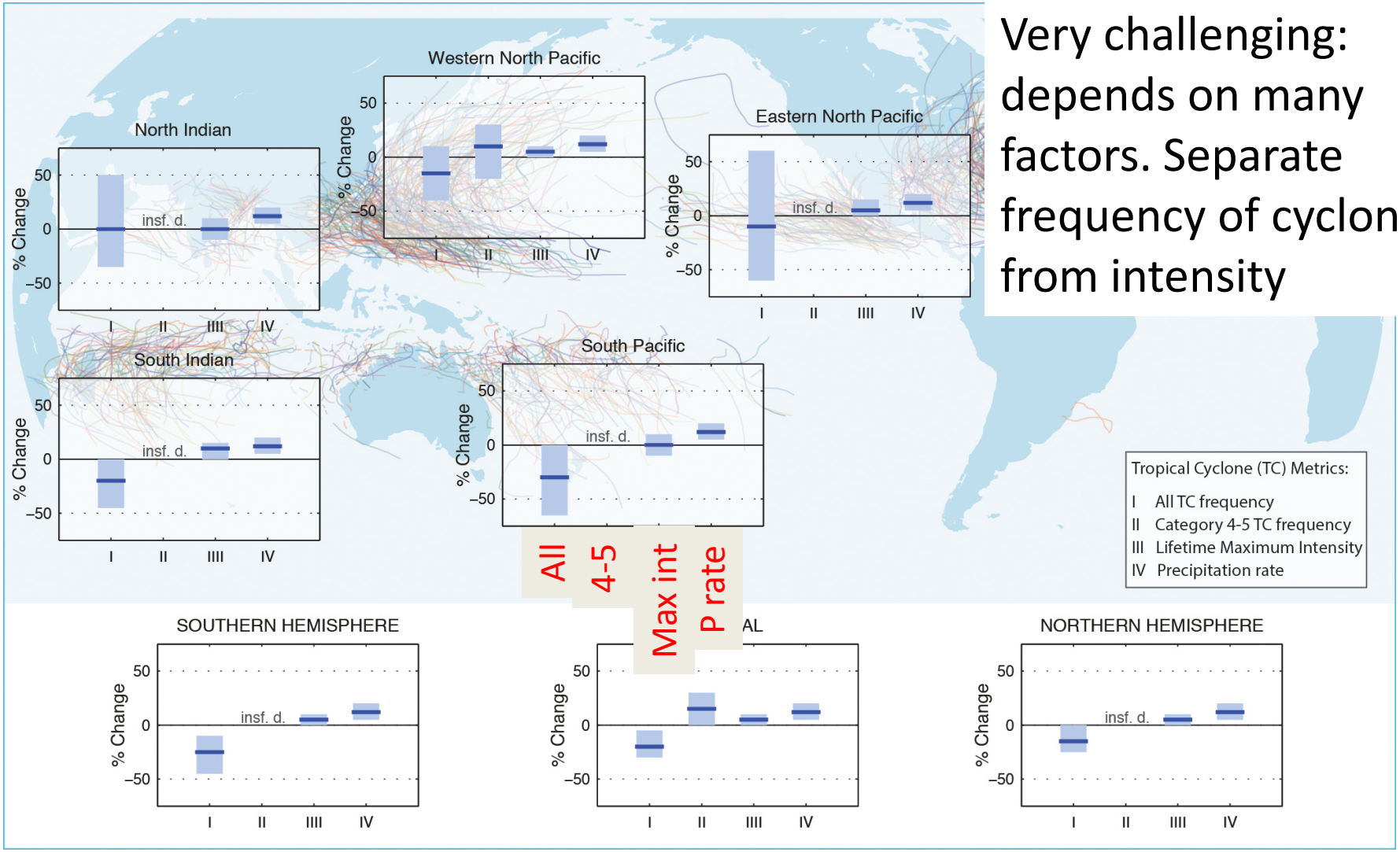


Fairly simple – basic thermodynamics

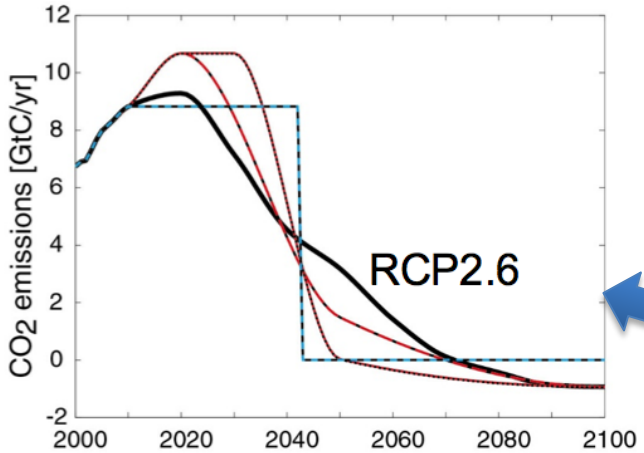
Global mean sea level will continue to rise:

Assume 1 m by 2100 excluding storm surge

Future tropical cyclone activity

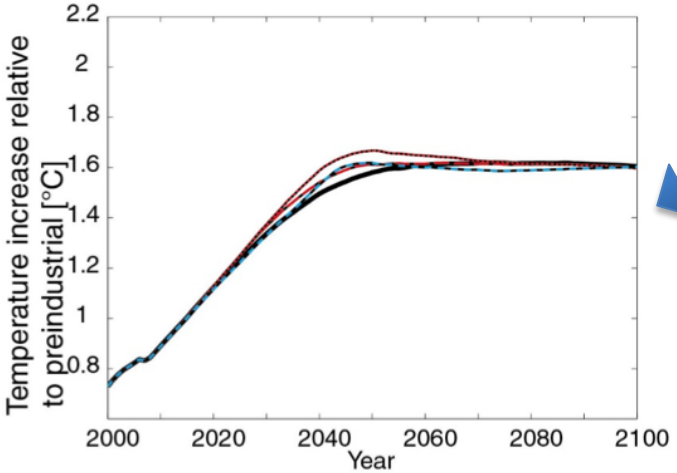


Very challenging: depends on many factors. Separate frequency of cyclones from intensity



- Warming is independent of the *timing* of emissions
  It's the *amount* that matters

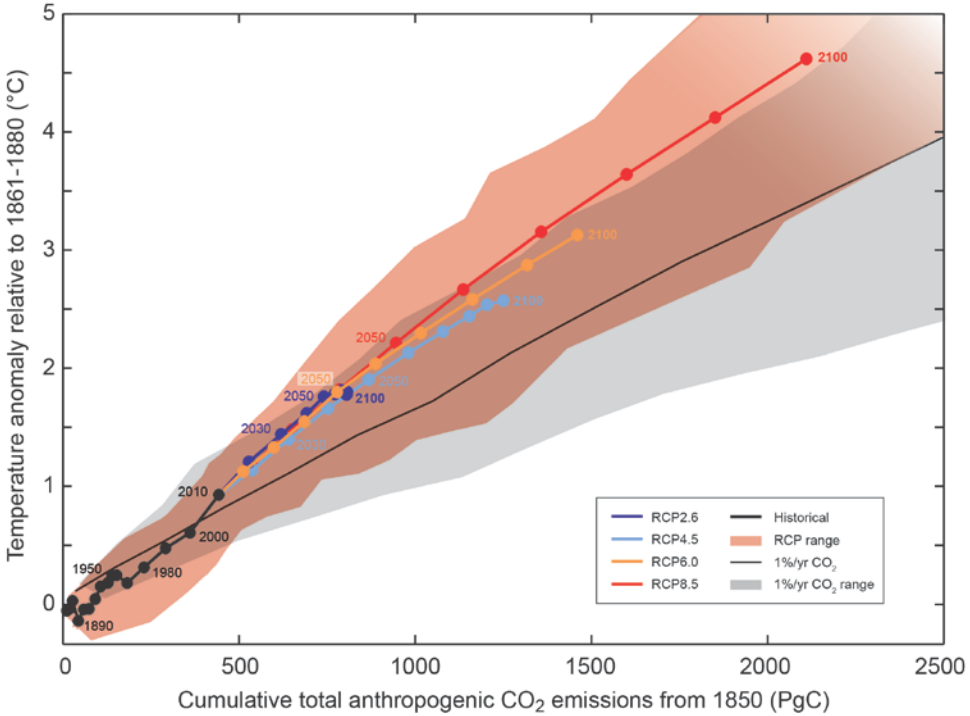
Different timing



Does not lead to different temperatures

- Timing of emissions is an economic and policy question

Cumulative carbon determines warming



- Every ton of CO_2 causes about the same amount of warming, no matter when and where it is emitted

- To limit warming to likely less than 2°C from CO_2 alone total emissions since pre-industrial need to be limited to less than 1000 GtC.

- About 550 GtC were emitted by 2011

- Already evidence of loss of CH4, slowing of biosphere sinks, ice melt …

- If implemented, this means most coal and oil <u>must</u> stay in the ground

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 – globe will exceed 2°C and plausibly 4°C meaning >4°C over land and plausibly 8°C *in the mean*

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.