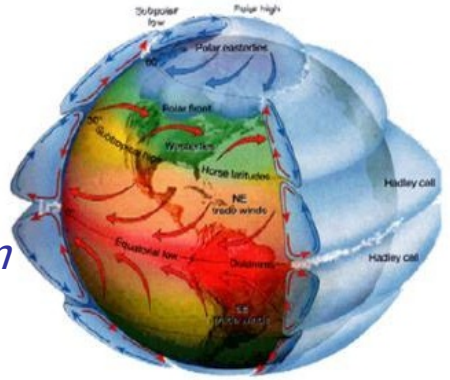
The Science, Psychology and Politics of Climate Change

Brian Spies FTSE FRSN

Society as a Complex System:
Implications for Science, Practice and Policy



The Royal Society of NSW and Four Academies Forum

Government House, Sydney

29 Nov 2016

Garnaut
CLIMATE CHANGE
REVIEW

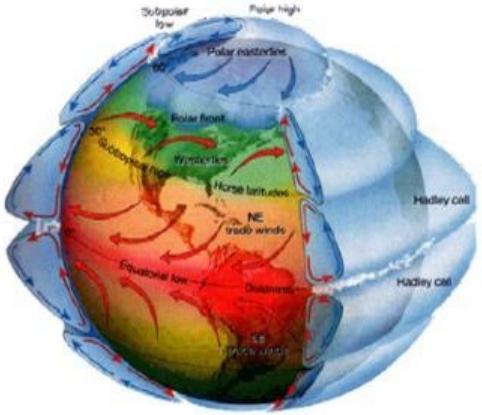
artwork

Evidence of global warming

"Hot with a chance of storm",
James Dive, Tamarama Beach, 2013

Climate Change Science

- Climate science
- Geological record
- Observations and trends
- Modelling projections

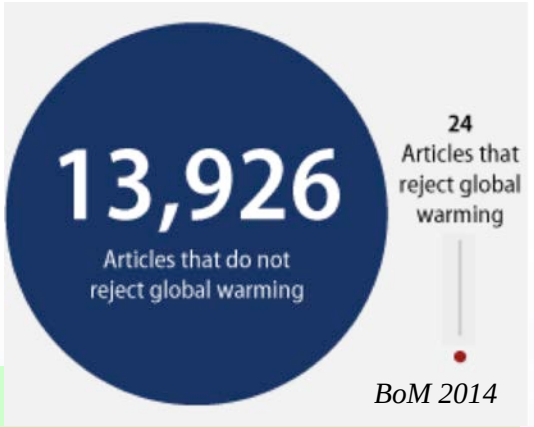


Sources

- *Australian Academy of Science*
- *CSIRO*
- *ANU*
- *BoM*
- *NASA*
- *IPPC*
- *World Bank ...*

What do scientists think?

“Consensus: 97% of climate scientists agree”



Statement on climate change from 18 scientific associations

"Observations throughout the world make it clear that climate change is occurring, and rigorous scientific research demonstrates that the greenhouse gases emitted by human activities are the primary driver.”

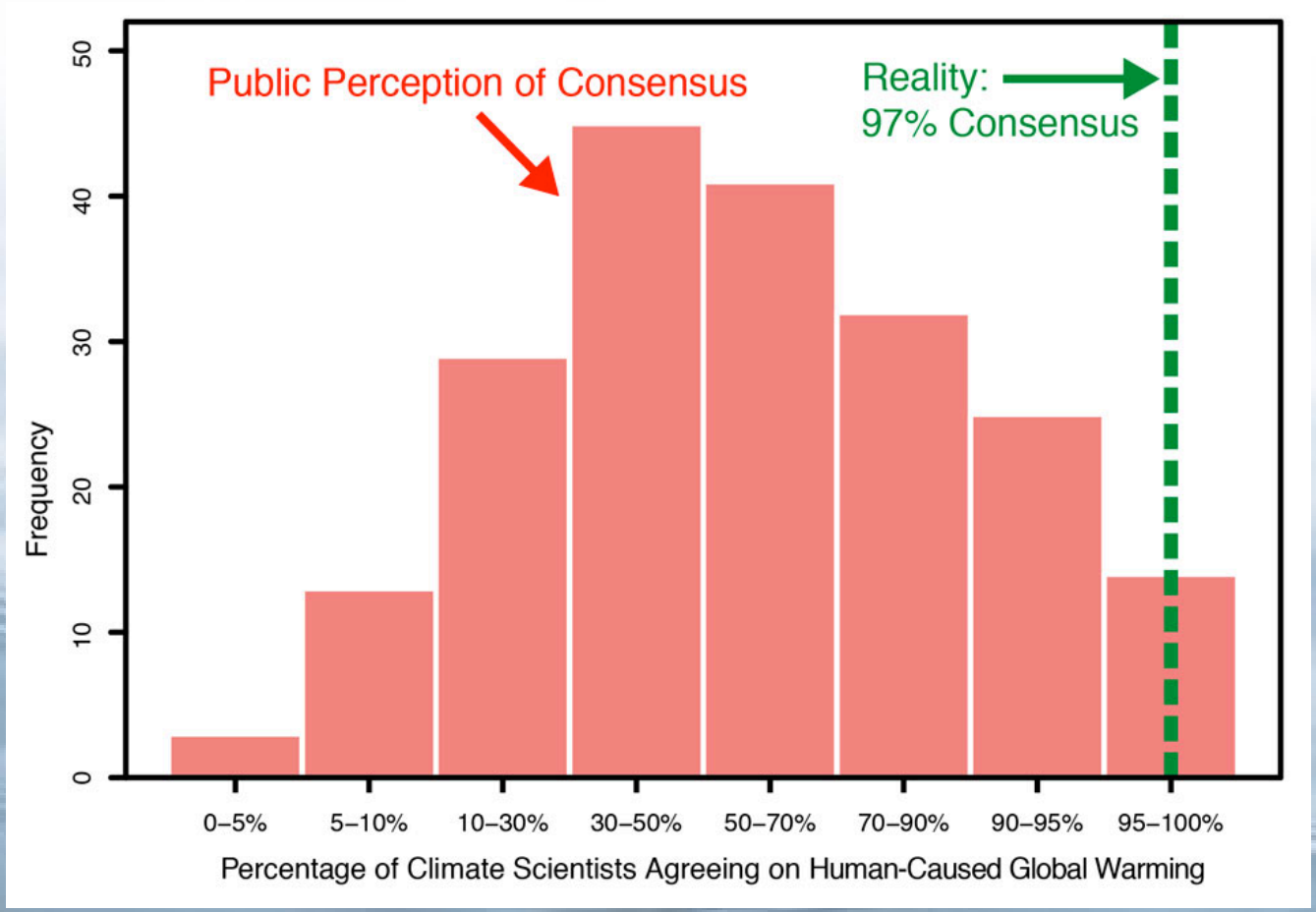
http://climate.nasa.gov/scientific-consensus

AAAS | ACS Chemistry for Life | AGU American Geophysical Union | AMA American Medical Association | American Meteorological Society

APS physics | The Geological Society of America | United States Global Change Research Program | ipcc

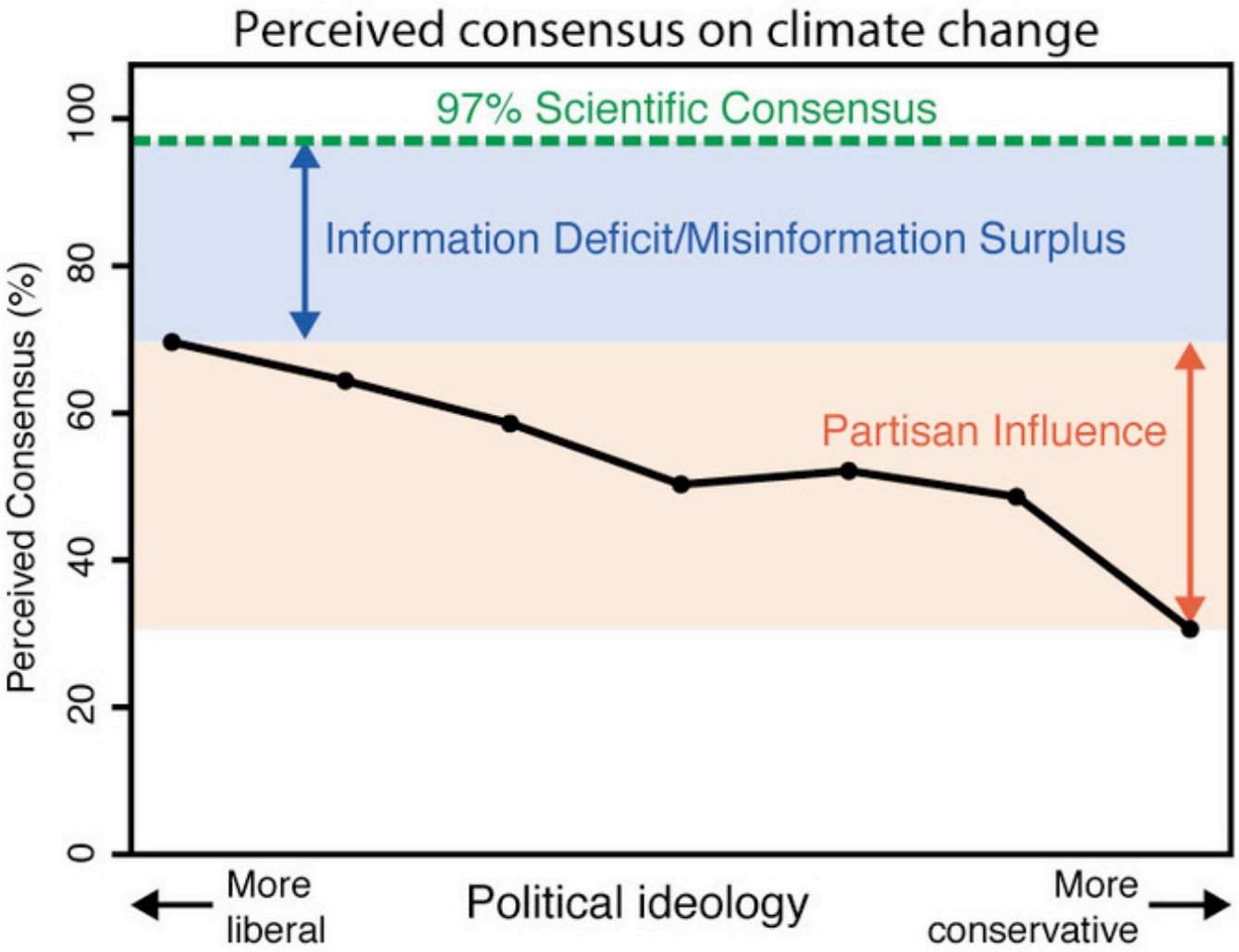
The consensus gap

"How many climate experts agree that the global warming we are witnessing is a direct consequence of the burning of fossil fuels by humans?"



US data (Skepticalscience.com; Doran & Zimmerman 2009, Anderegg et al 2010, Cook et al., 2013)

Political ideology



The Conversation, 28 Nov16

Climate Change Politics

- Vested interests, misinformation
- Deny the science – confuse the issues
- Mismatch between GHG emitters and communities most affected
- Mitigation has short-term costs long-term benefits
- Big stakes; no easy answers
- Winners and losers
- Rent seekers (the free lunch)
- Market failure (tragedy of the commons)
- Developed world vs emerging economies (global politics)

A diabolical problem

"Climate change is a "diabolical" policy problem, the hardest policy problem in living memory … The most inappropriate response would be to delude ourselves, taking small actions that create an appearance of action, but which do not solve the problem.

Ross Garnaut, 2008

"The greatest moral, economic and social challenge of our time."

"We should be at a stage in this country that climate change is beyond politics.

Kevin Rudd, 2007

"A psychologists could barely dream up a better scenario for paralysis than climate change.

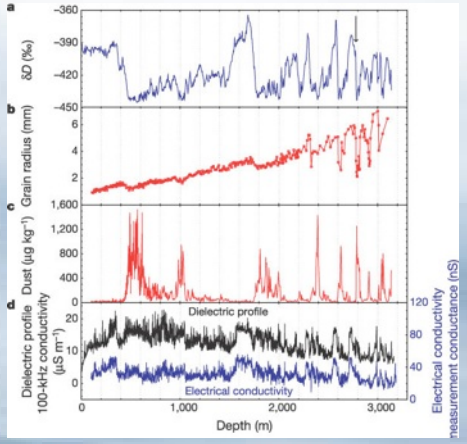
... Daniel Gilbert, Harvard University

"I am very sorry, but I am deeply pessimistic. I really see no path to success on climate change.

Daniel Kahneman, 2014

What is Science?

- observation
- hypothesis
- experimentation
- theory
- test
- consensus
- paradigm
- challenge

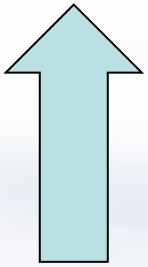


Science is not a “belief”

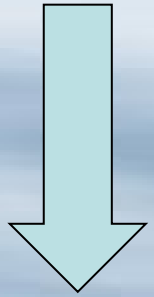
Key questions – from straightforward to 'diabolical"

1. Is the world's climate changing?
2. Is this a problem? Why?
3. But hasn't climate always changed?
4. Do we know what causes climate to change?
5. Do people play a role, and if so how much?
6. Can we slow down climate change by reducing greenhouse gas emissions?

SCIENCE



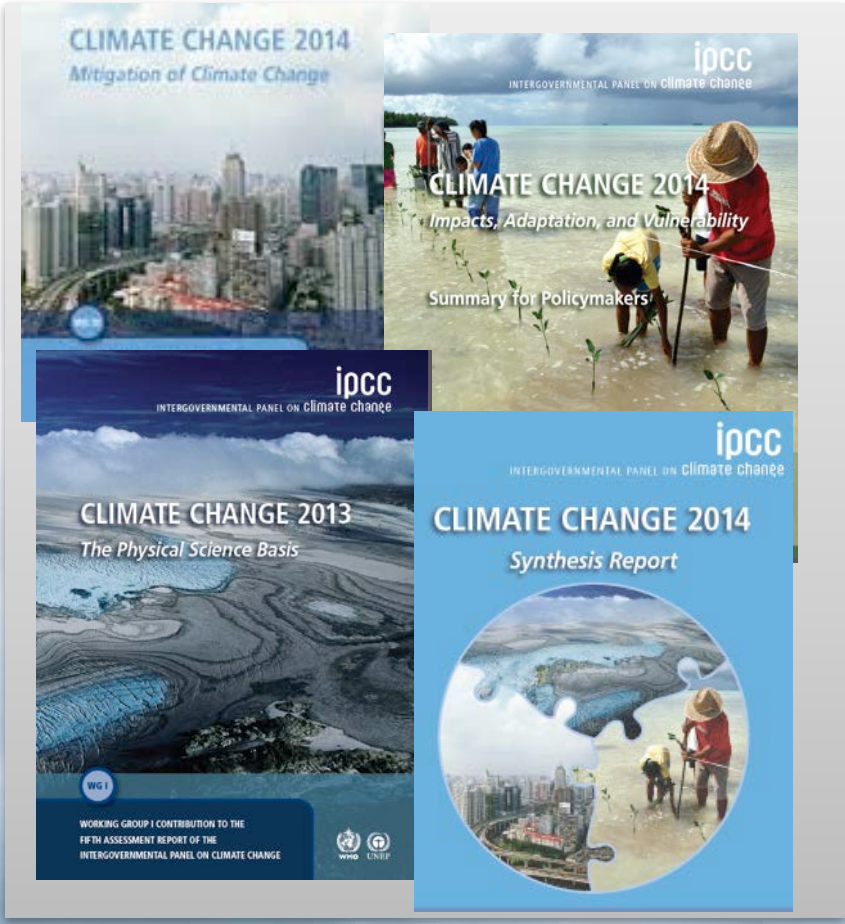
7. How much will it cost to act? The cost not to act?
8. Will there be winners and losers?
9. What is the best approach (legislation, market)?
10. Shouldn't we wait until others reduce their emissions (eg China, India, USA ...)?



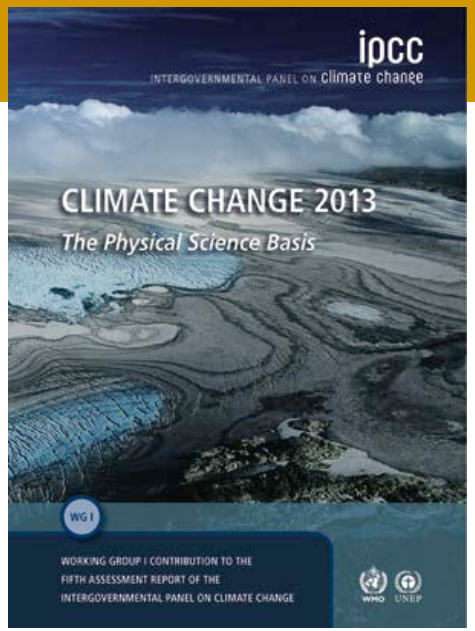
SOCIO-ECONOMIC, POLITICS

The Intergovernmental Panel on Climate Change (IPCC)

- Three thousand peer-reviewed papers on climate science are published each year
- The IPCC is a transparent process set up by the UN to summarise the world's peer-reviewed scientific papers into a form acceptable by all governments
- First assessment 1990
- 5th IPCC report 2014
- Over 1000 lead and contributing authors + expert reviewers and editors



Summary for Policymakers



Data (observations)

Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased.

Models (drivers of climate change)

Total radiative forcing is positive, and has led to an uptake of energy by the climate system. The largest contribution to total radiative forcing is caused by the increase in the atmospheric concentration of CO_2 since 1750.

Interpretation (understanding the changes)

Human influence on the climate system is clear. This is evident from the increasing greenhouse gas concentrations in the atmosphere, positive radiative forcing, observed warming, and understanding of the climate system.

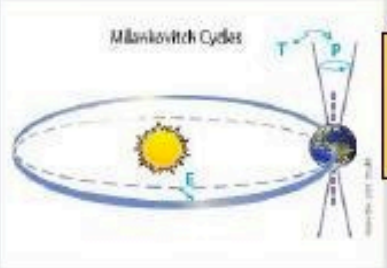
Prediction (future climate)

Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system.

Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions.

Many factors act to change our climate on various timescales

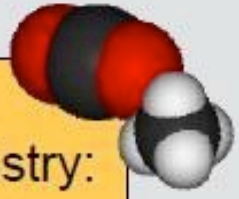
- Physical 'external' factors



Orbital Changes:
millenia

Solar Changes:
millenia to decadal

Changes in Atmospheric Chemistry:
millenia to years

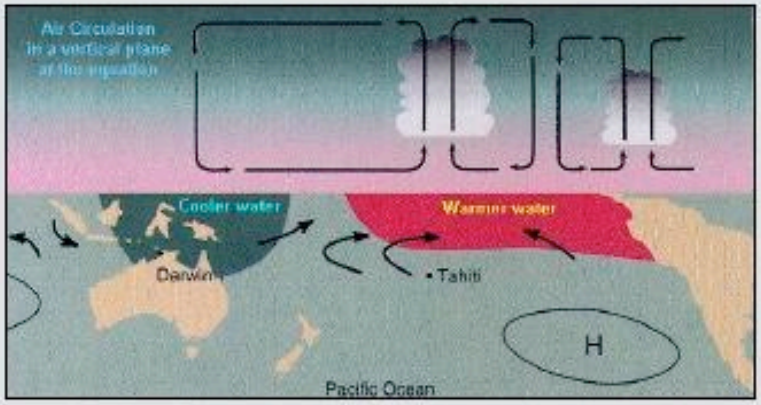


Volcanic Eruptions:

years

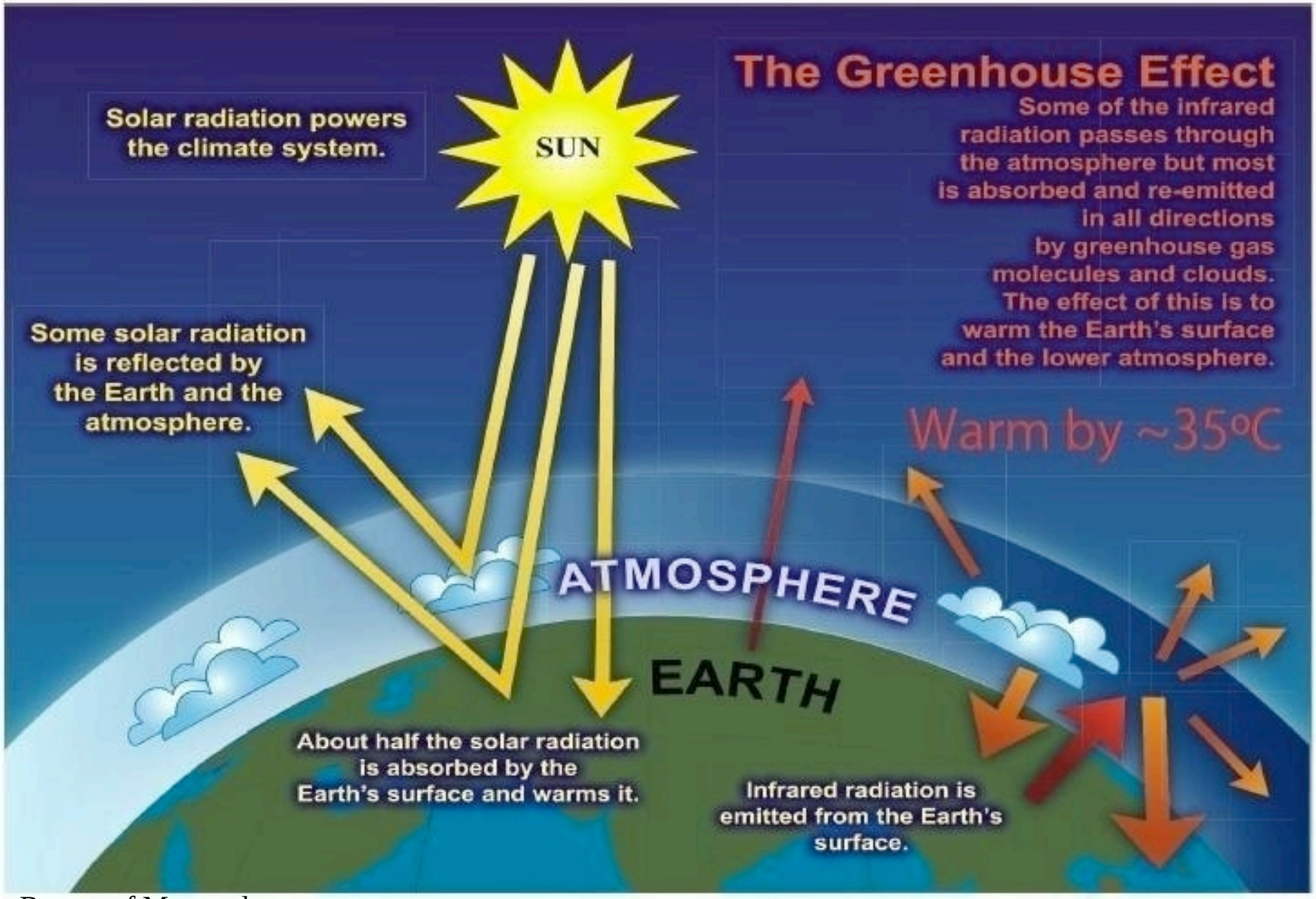
- Intrinsic 'internal' factors

The El Nino Southern Oscillation:
year-to-year, month-to-month



Source: Bureau of Meteorology

Greenhouse gases are an important component of the atmospheric system



Source: Bureau of Meteorology

’Night Lights’ of Earth

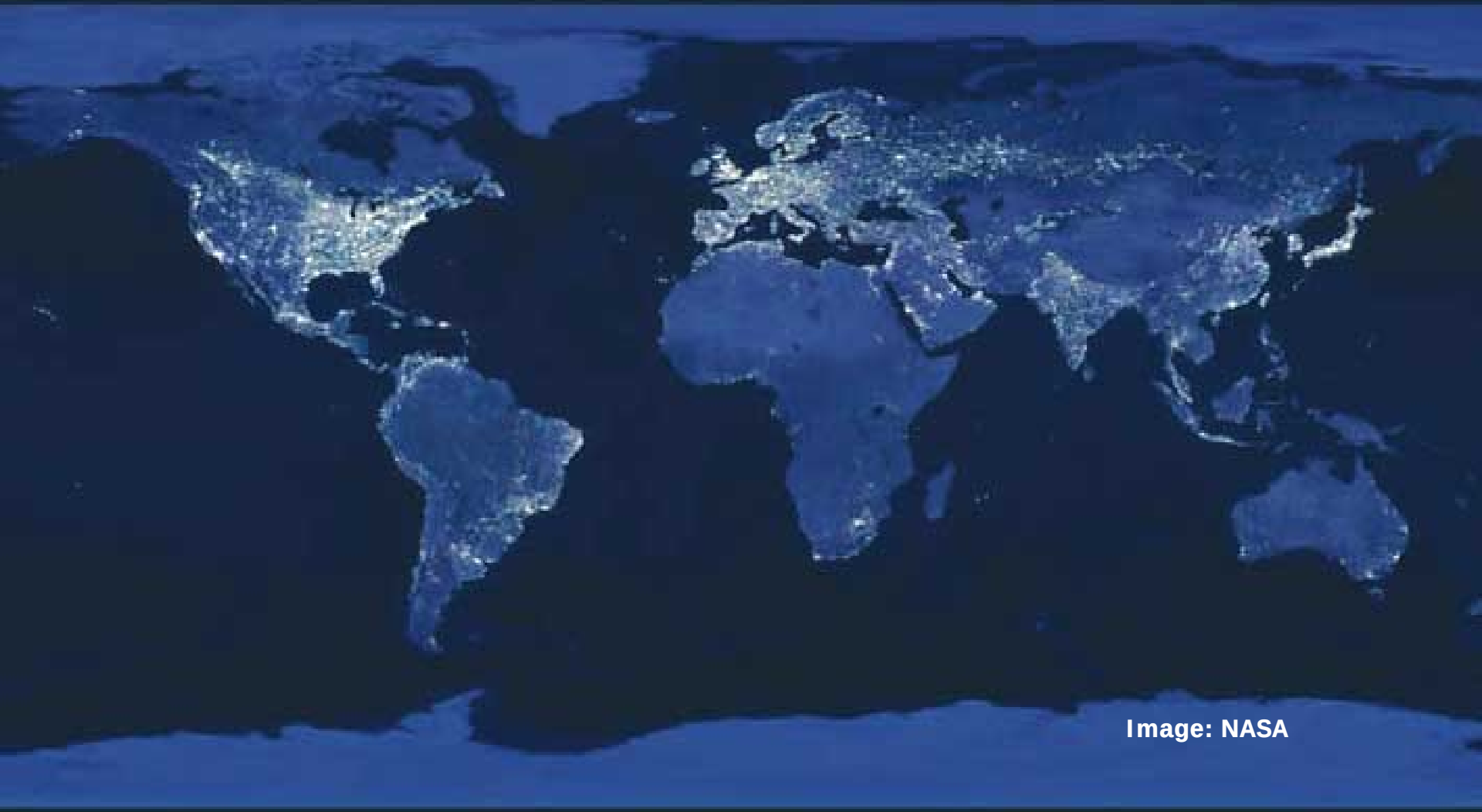
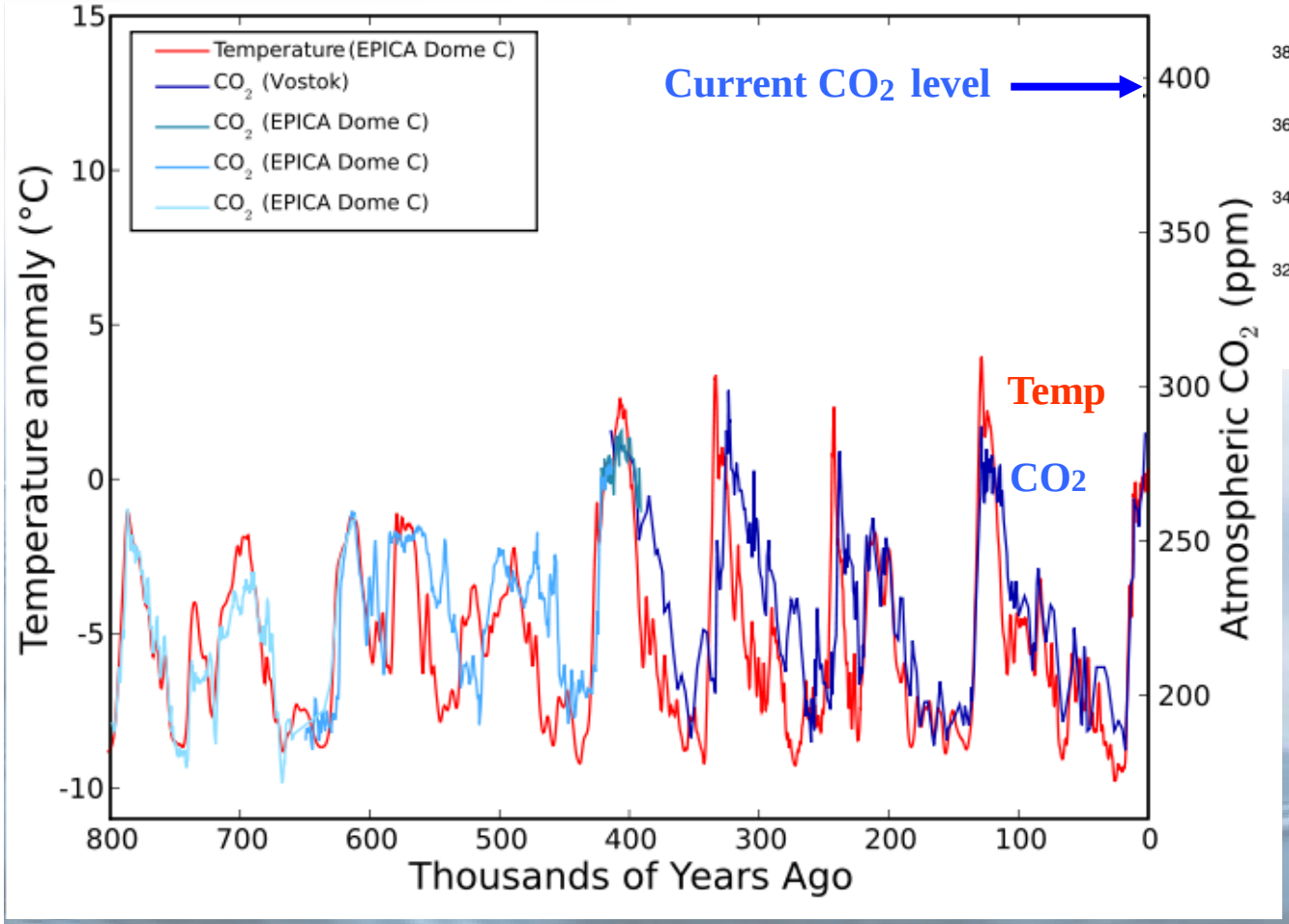
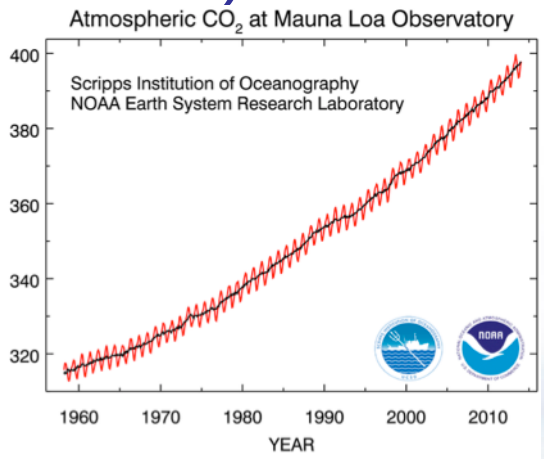


Image: NASA

Human activities contribute

Temperature and CO_2 (800,000-year record)





Reconstruction from Antarctica ice

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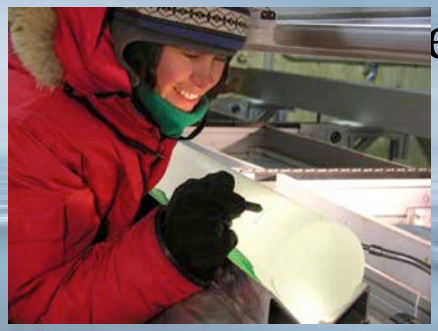
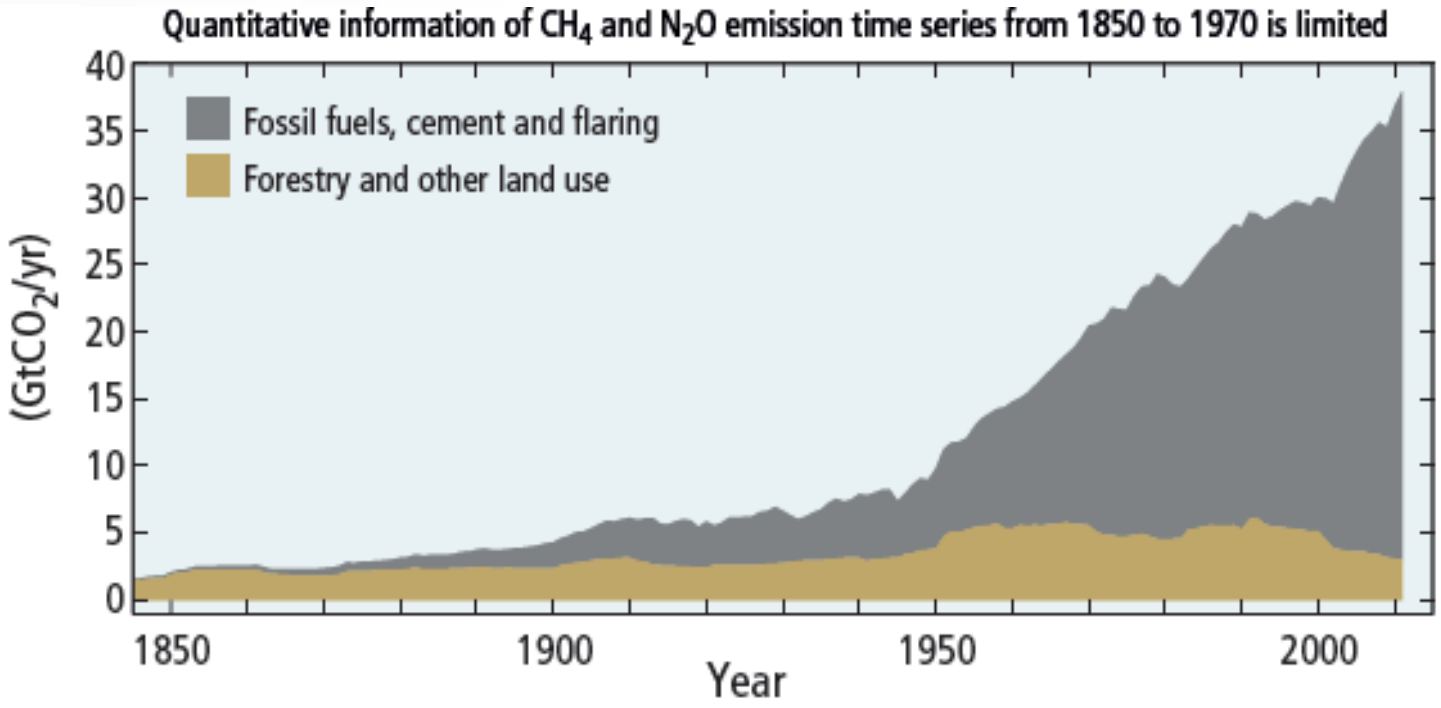
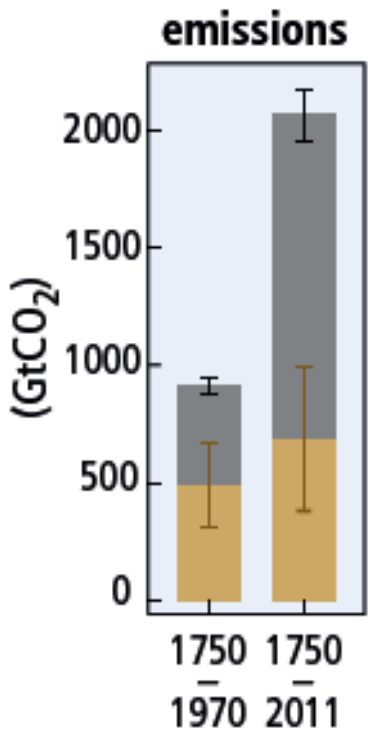
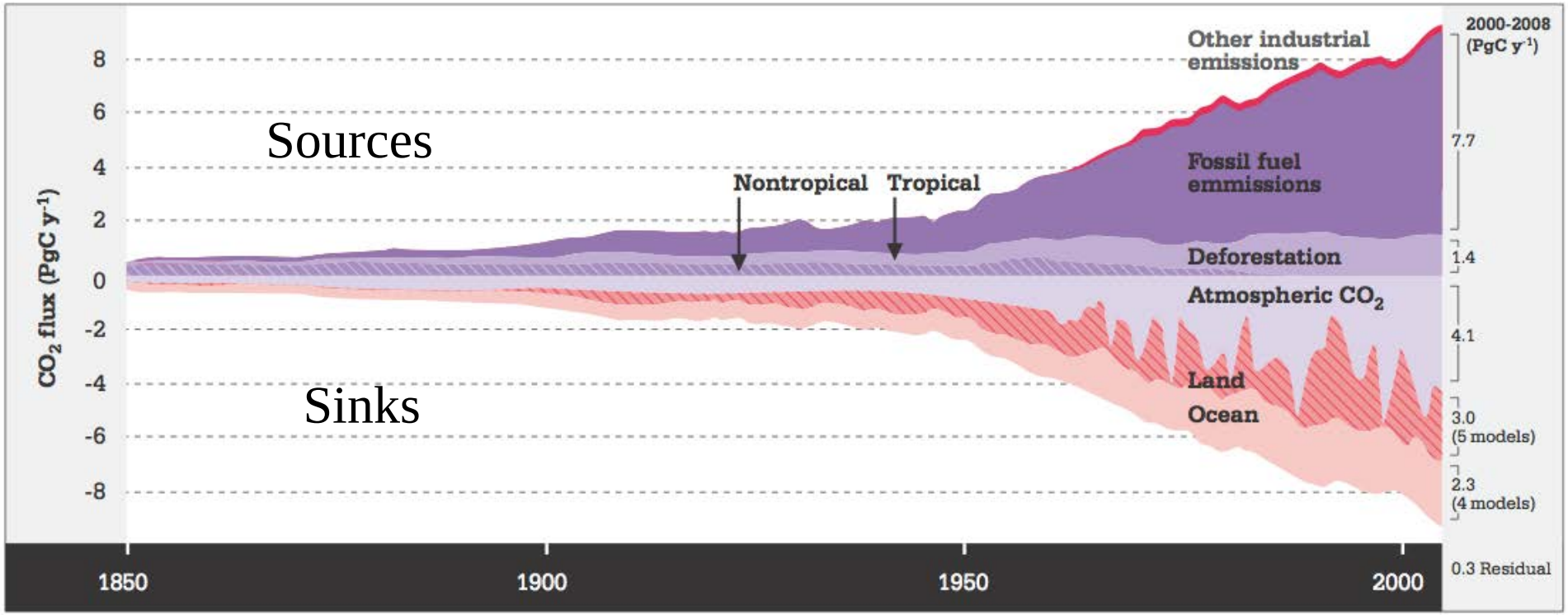


Global anthropogenic CO_2 emissions





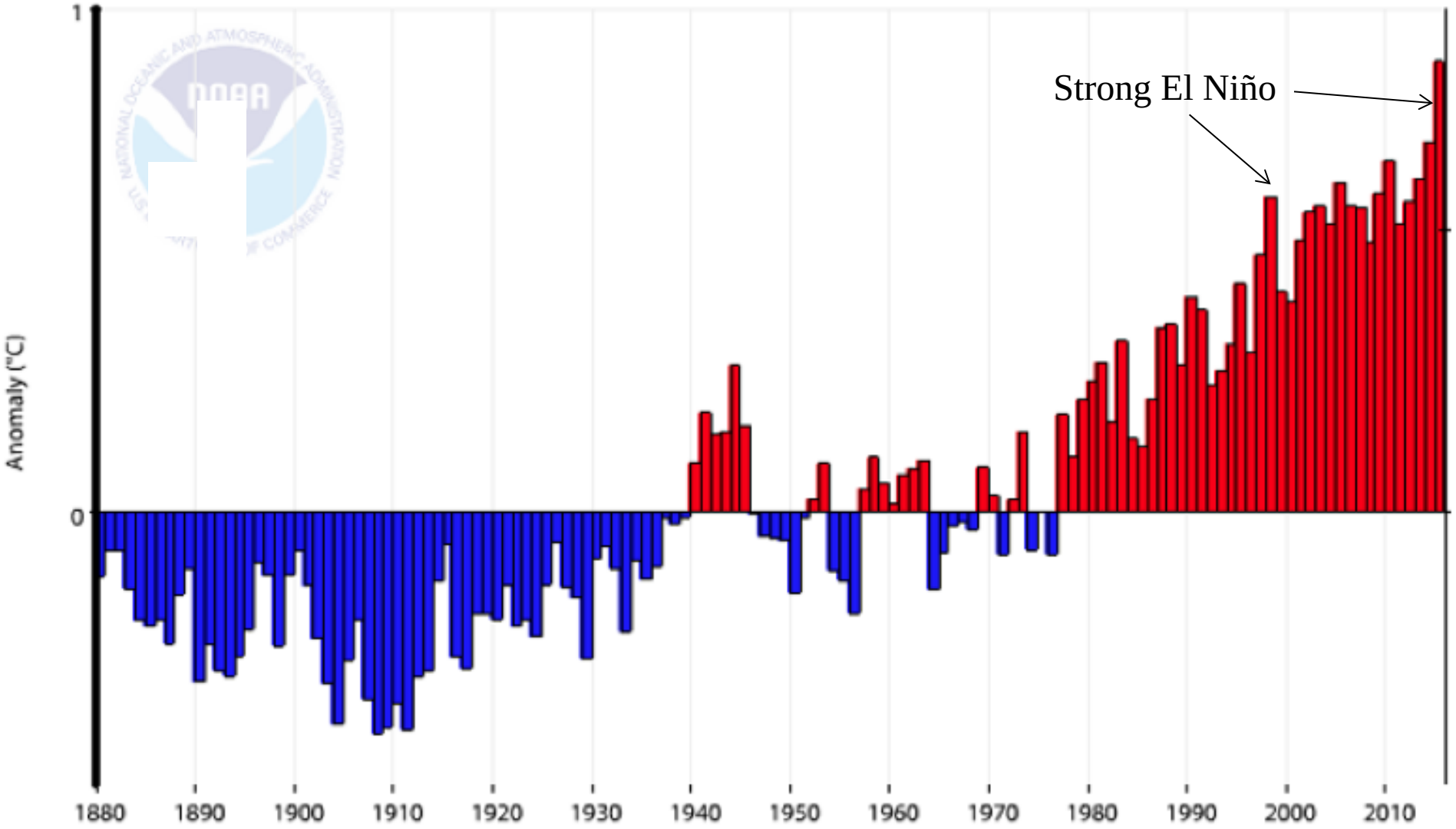
Global CO_2 budget, 1850 - 2008



Half the CO_2 emitted stays in the atmosphere and lasts 50-100 years

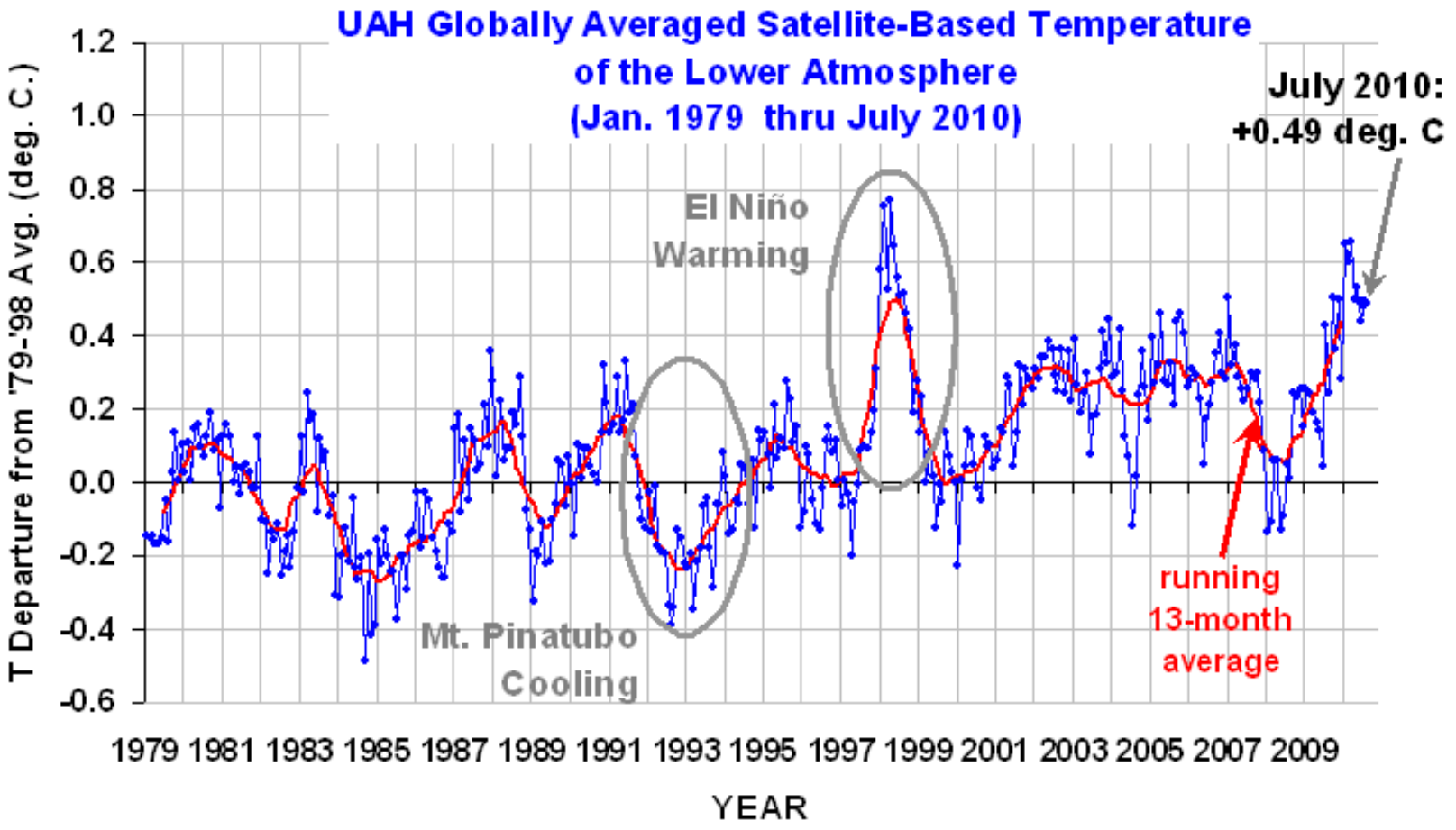
Source: Climate Commission

Global land and ocean temperatures since 1880



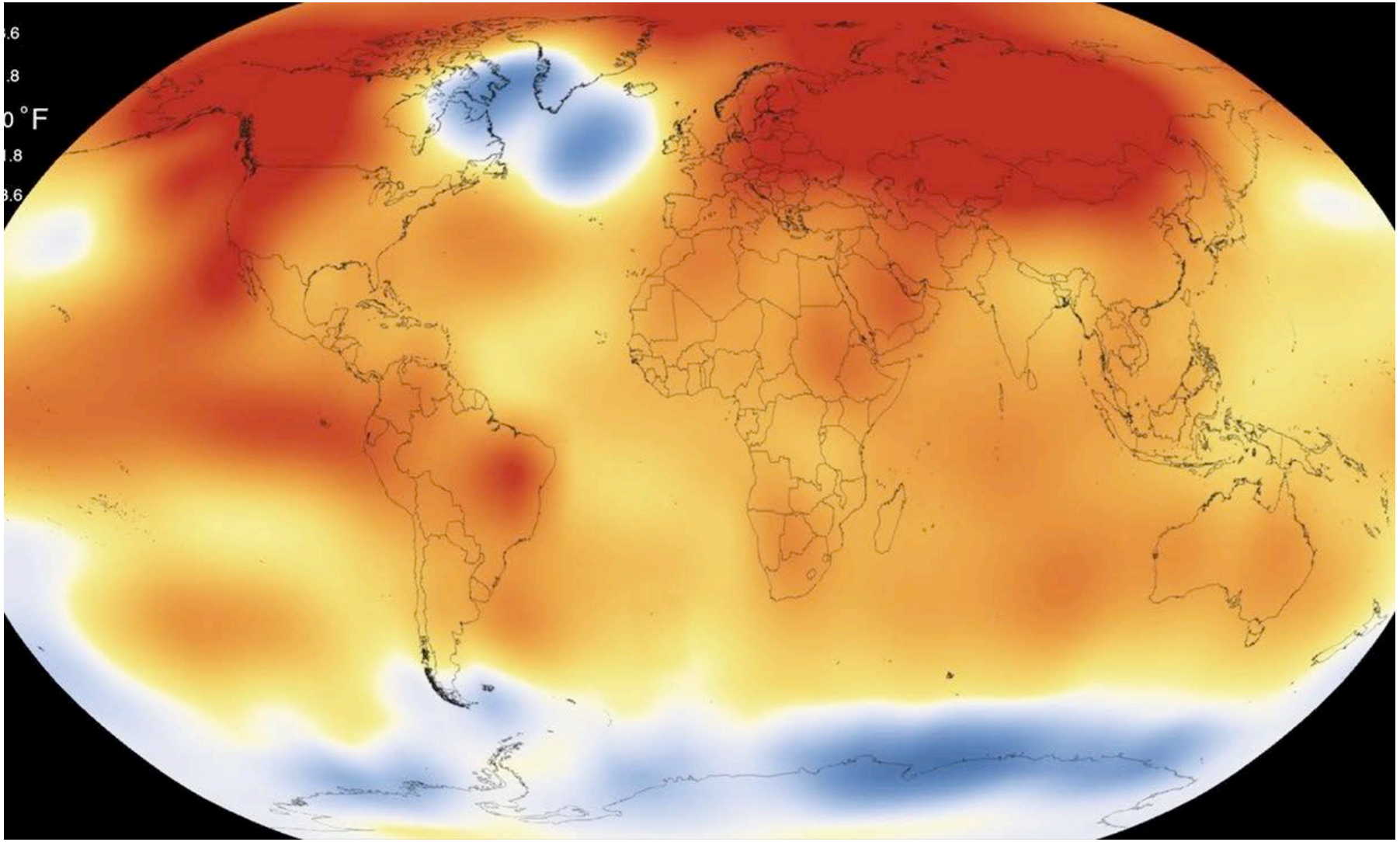
Source: NOAA

Lower atmosphere temperature



NASA AMSU-A satellite data

2015 “Hottest year on record”

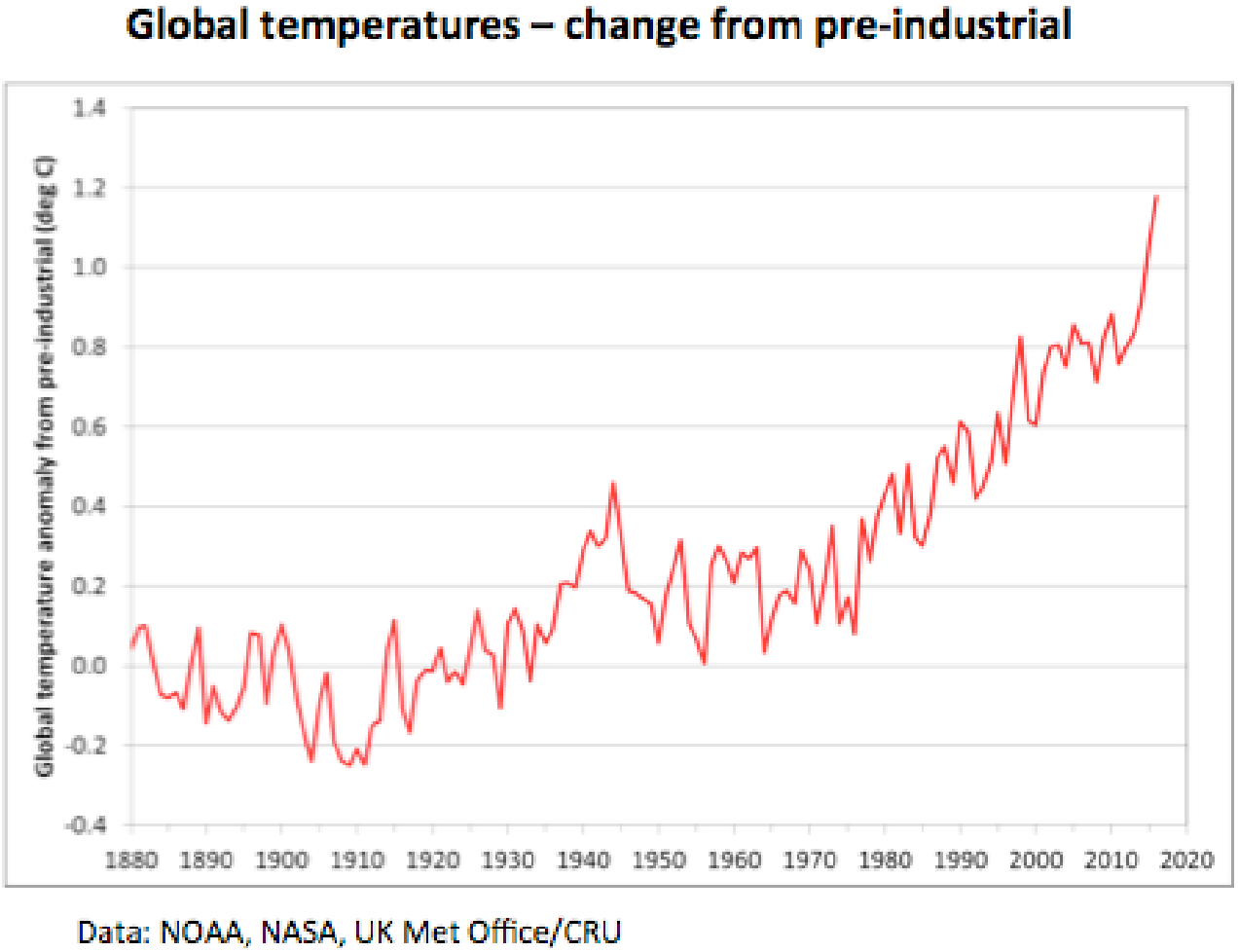


Global temperatures 1.0˚ C warmer than preindustrial times

NASA

WORLD METEOROLOGICAL ORGANIZATION

2016 “Hottest year on record”

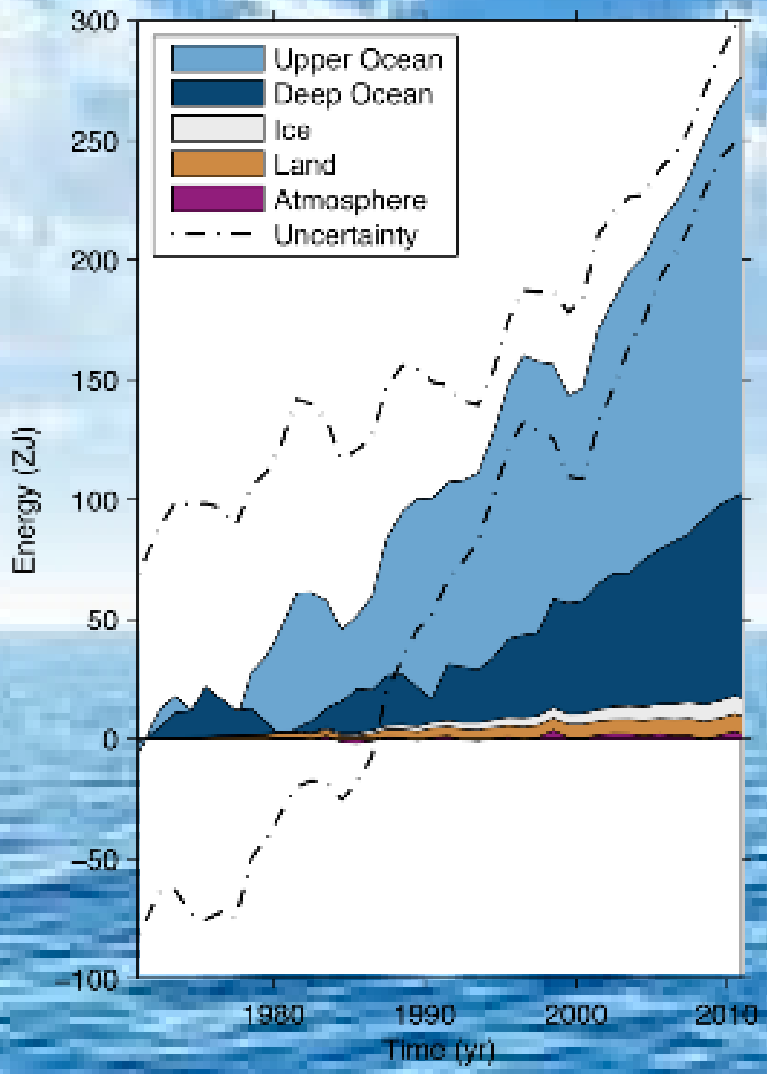


Global temperatures 1.2˚ C warmer than preindustrial times

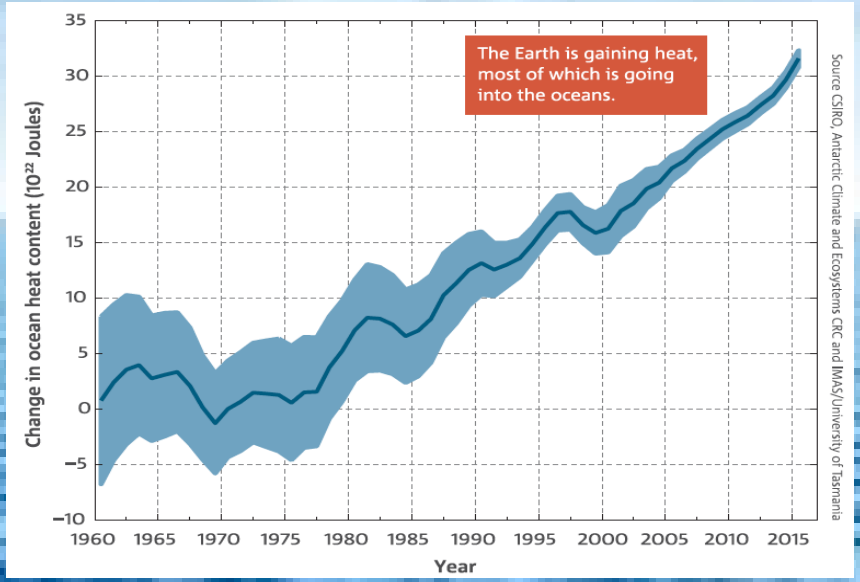
WMO, 14 Nov 2016, Marrakech

The oceans play a key role

Ocean heat content

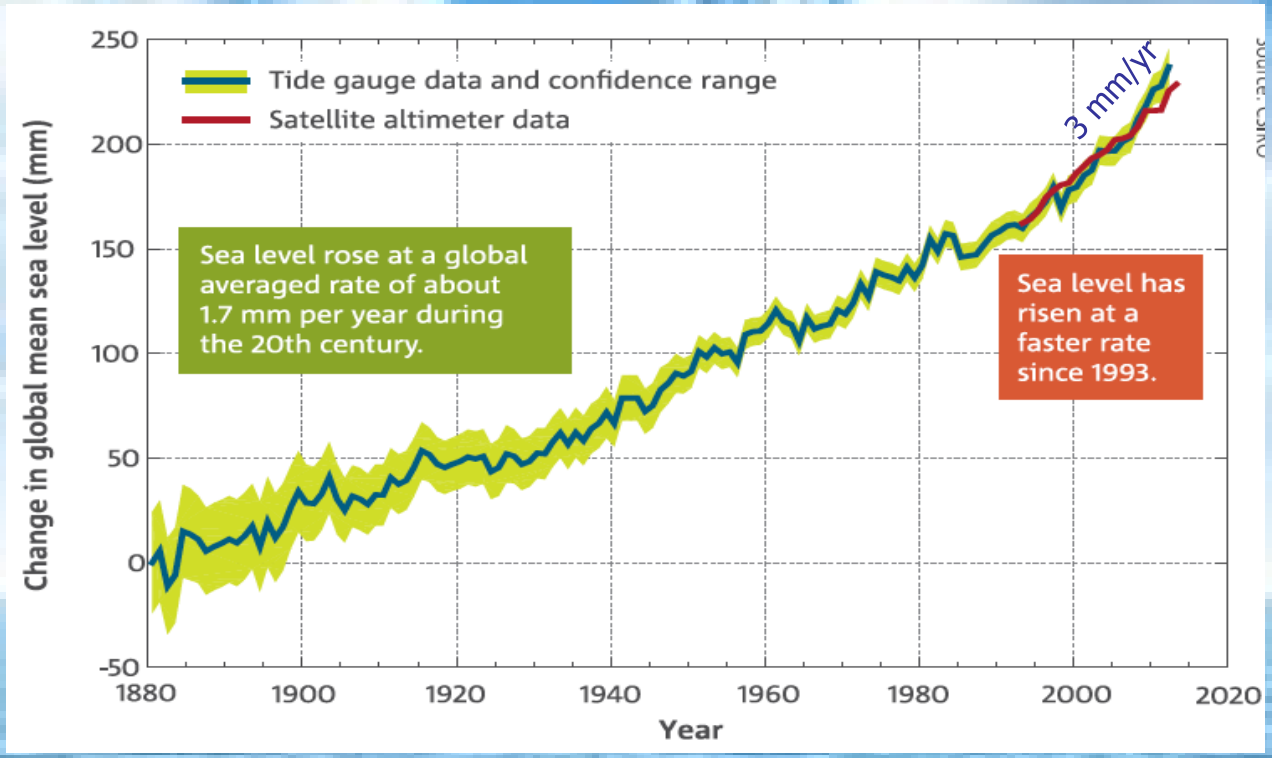


"93% of excess heat trapped by GHGs goes into the oceans"



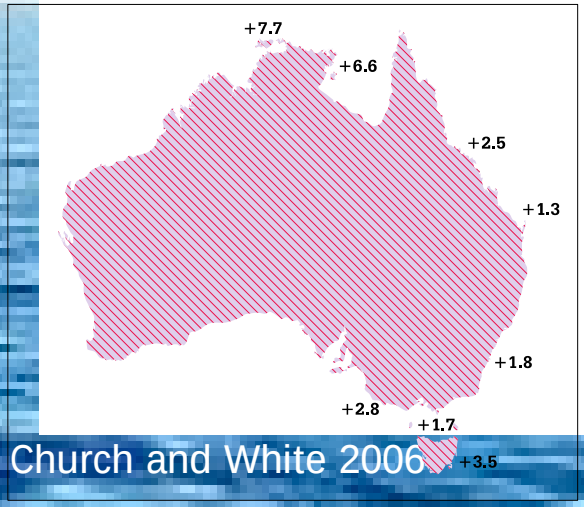
IPCC 2013; oceansciences.org

Global sea level rise



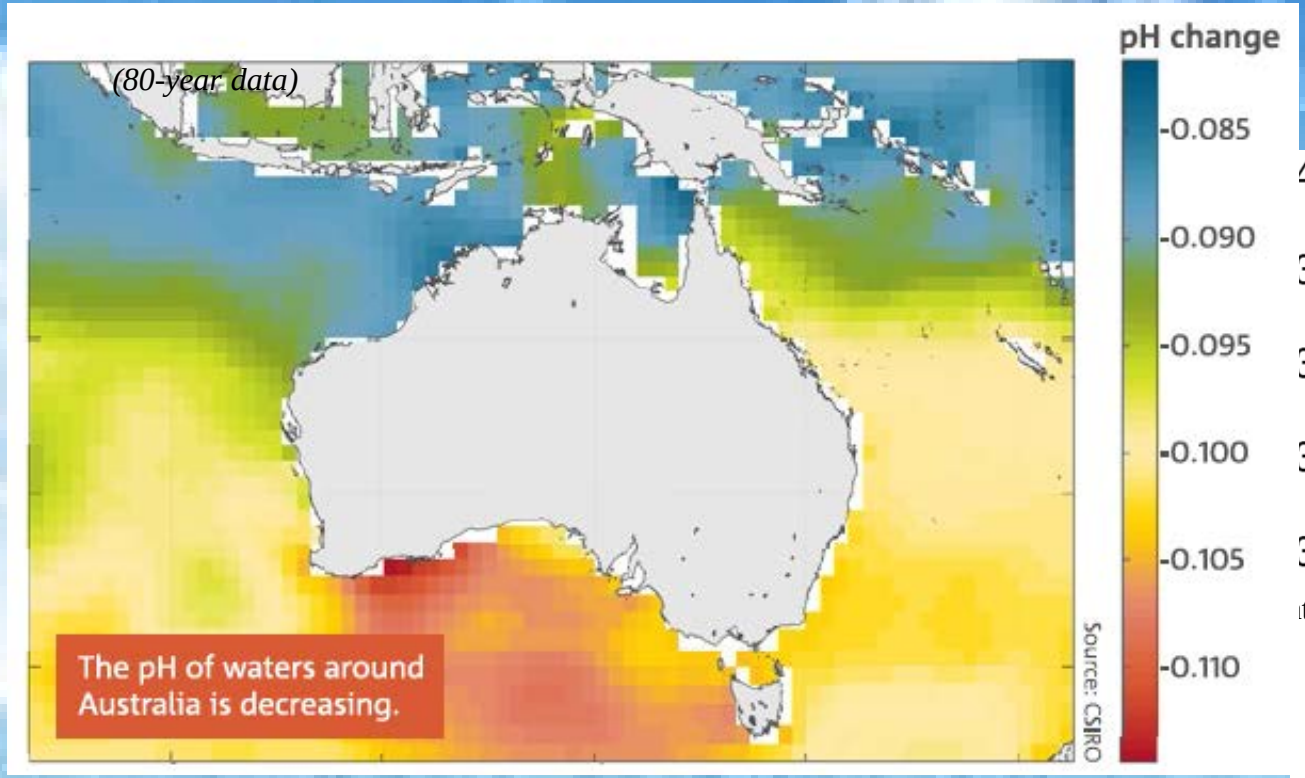
"Half of sea level rise is caused by thermal expansion, and half by melting ice caps and glaciers currently grounded on land"

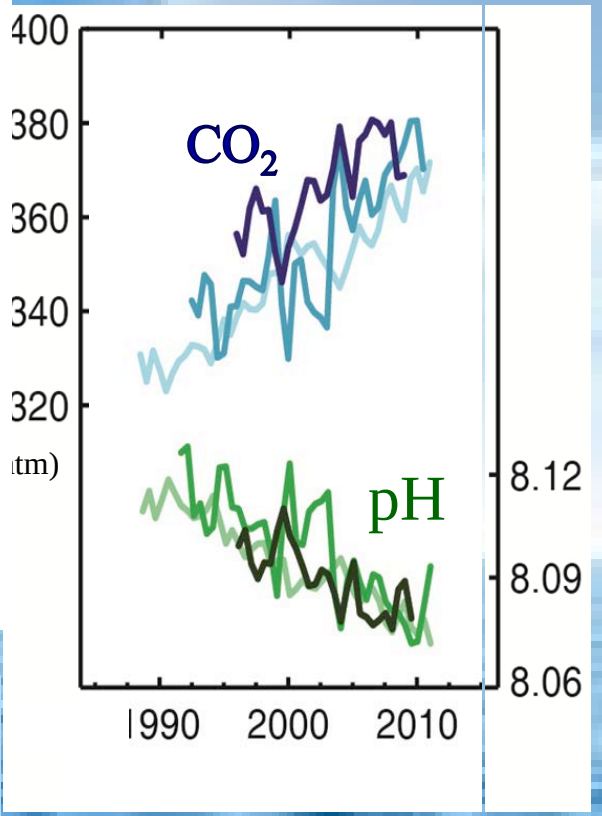
Figure 8. Local sea-level rise (mm/year) around Australia from the early 1990s to 2008.



IPCC 2013; Univ Colorado, CSIRO, Scripps

Oceans are acidifying



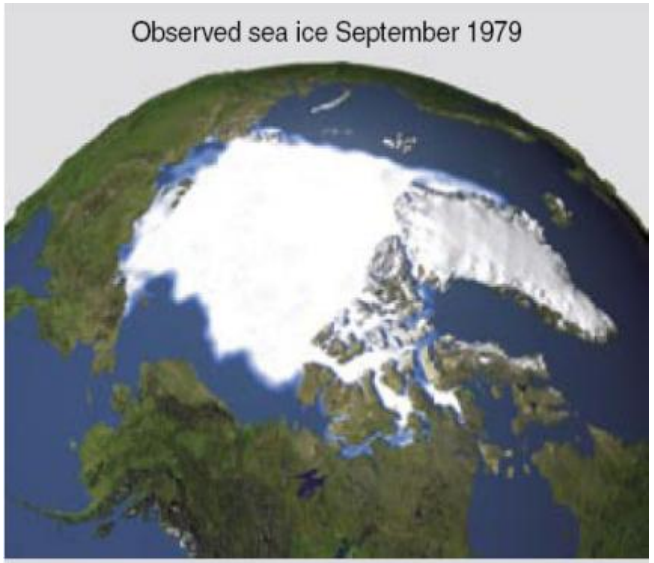


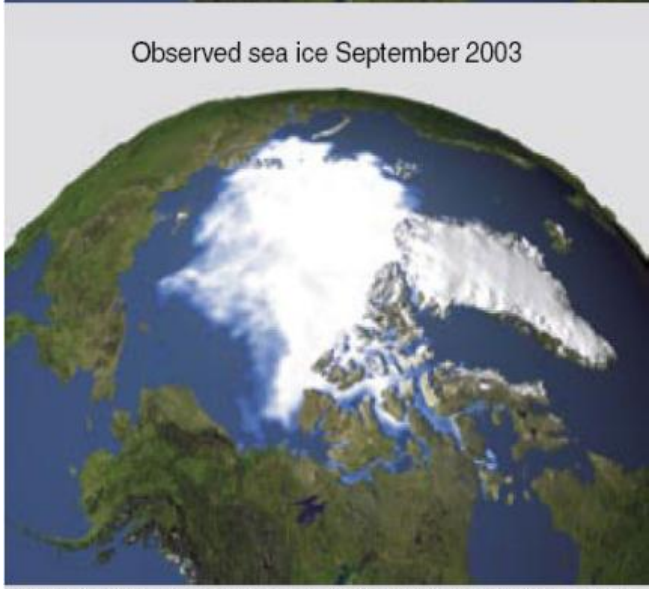
"One-third of human-produced CO2 has been absorbed by the oceans"

"The last time the oceans were this acidic was 53 million years ago"

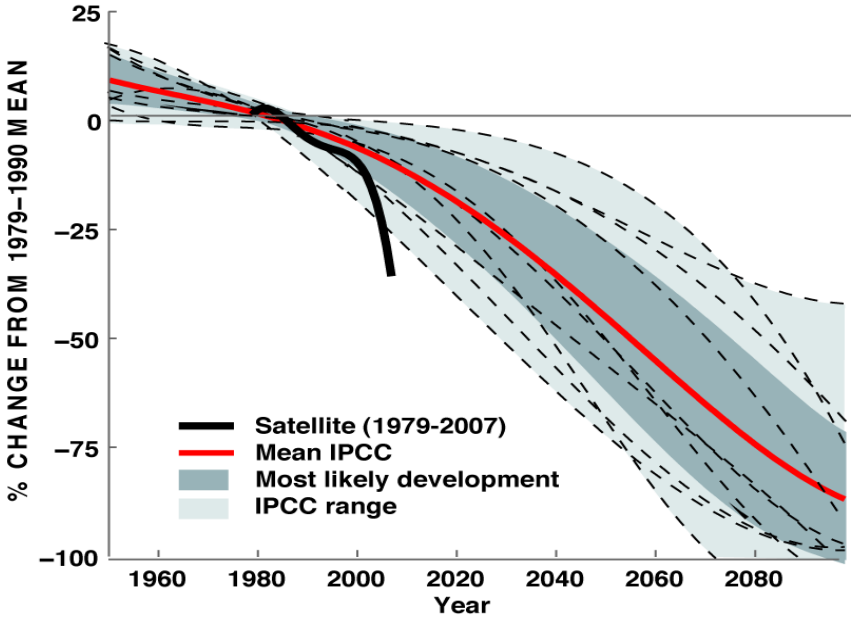
Source: IPCC, CSIRO, Scripps

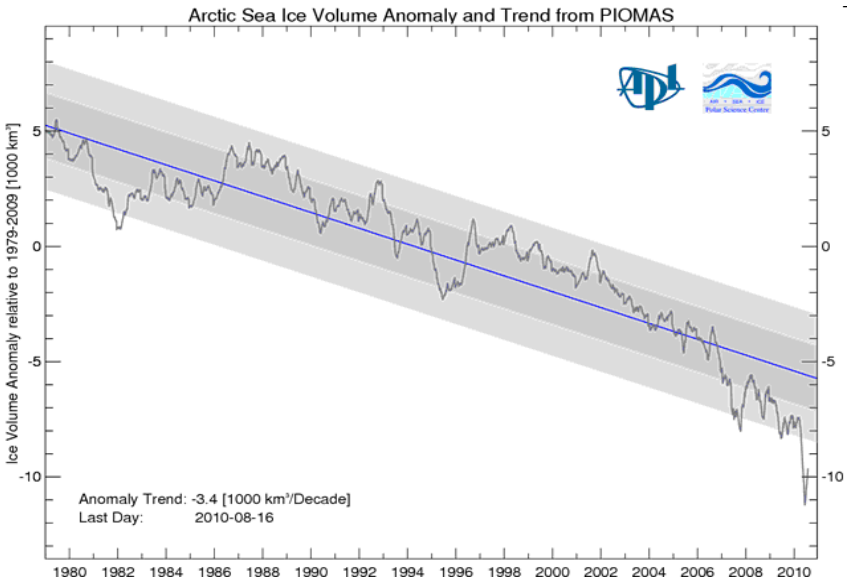
Arctic Sea Ice





Source: Arctic Climate Impact Assessment (ACIA), 2004. Impacts of a Warming Arctic.





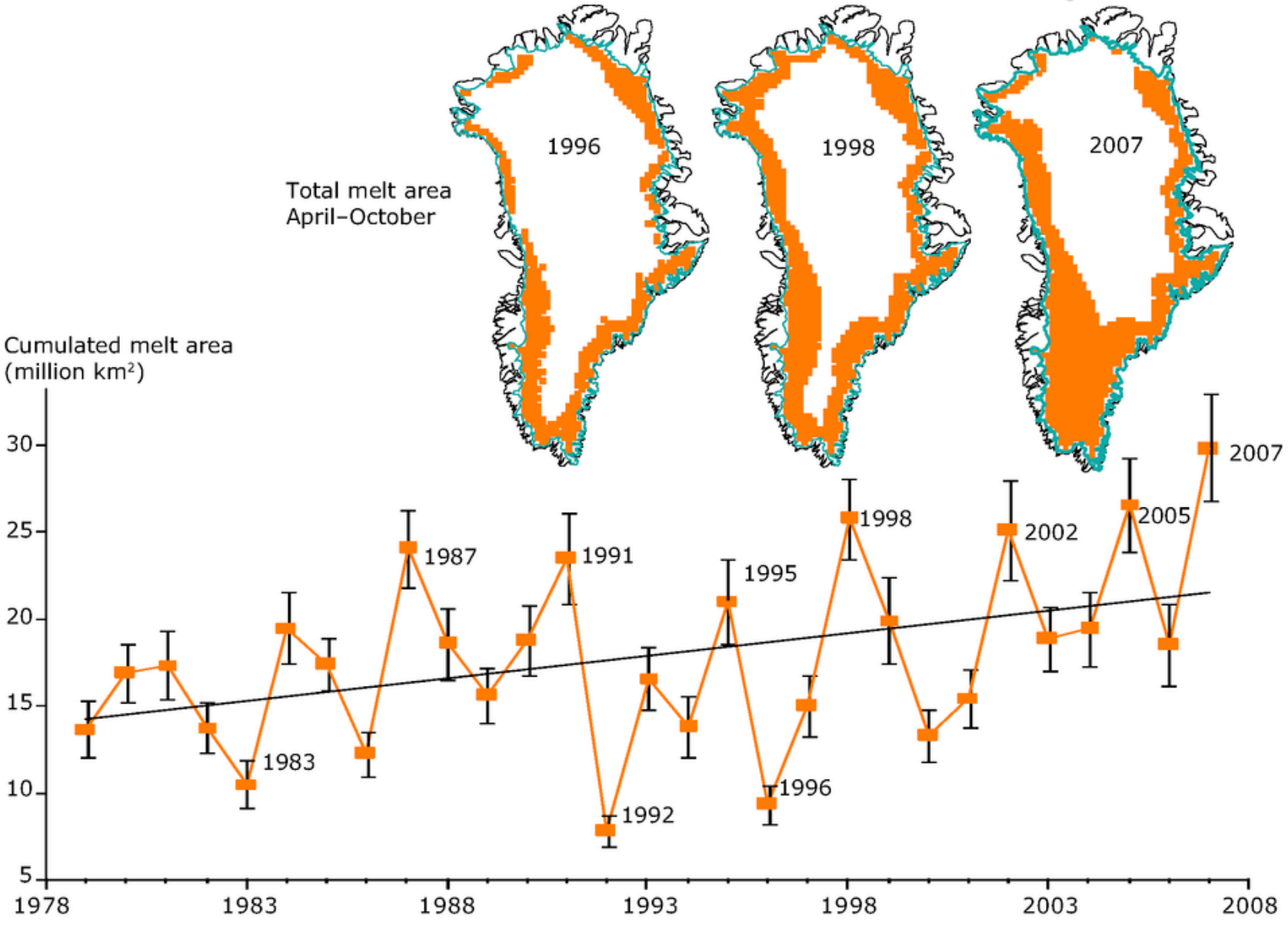
1980-2010 (University of Washington Polar Science Center); A Sortenberg

Ice melt in Greenland

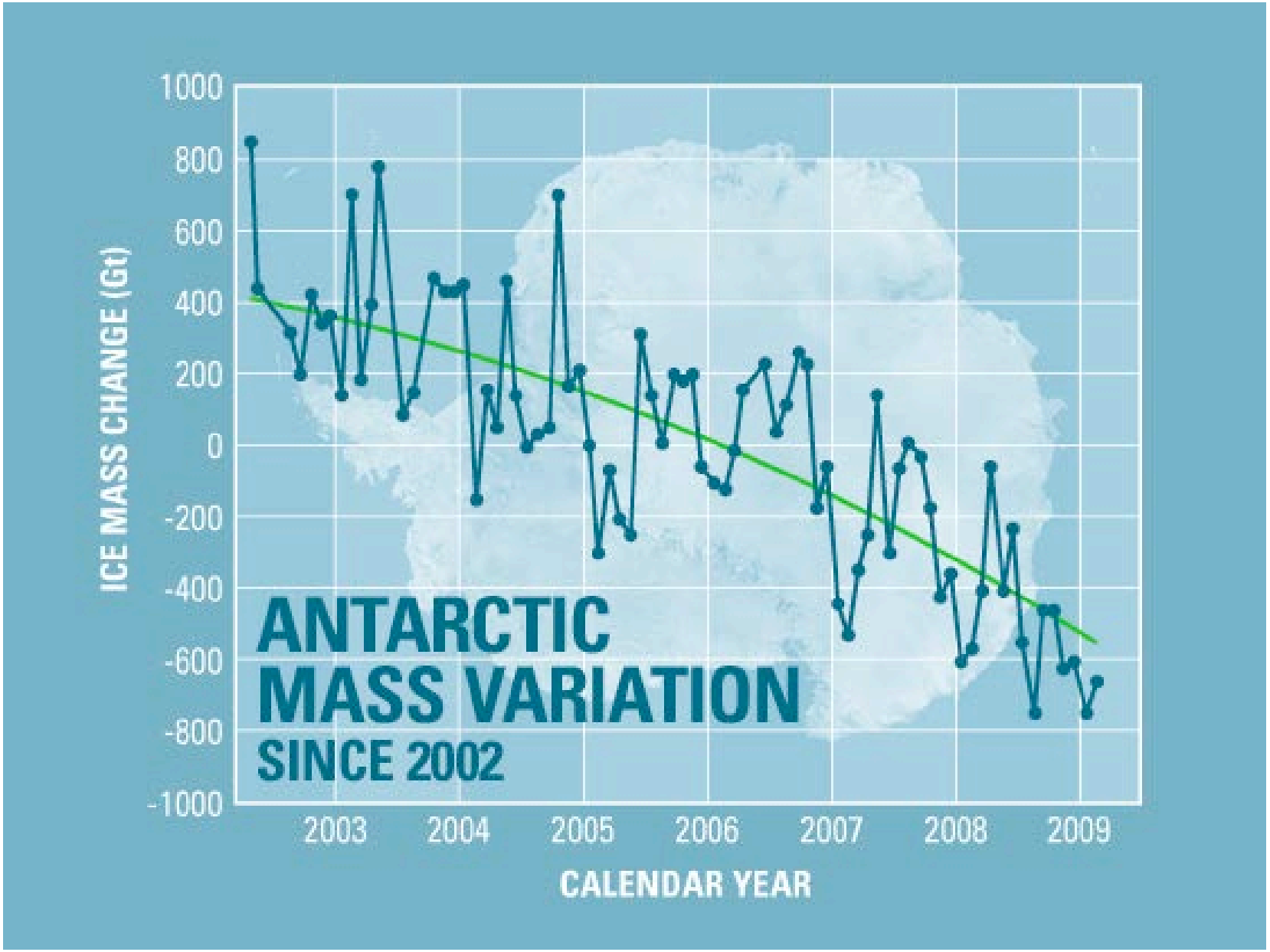
Meltwater descending into a moulin, a vertical shaft carrying water to ice sheet base

Source: Roger Braithwaite, University of Manchester (UK)

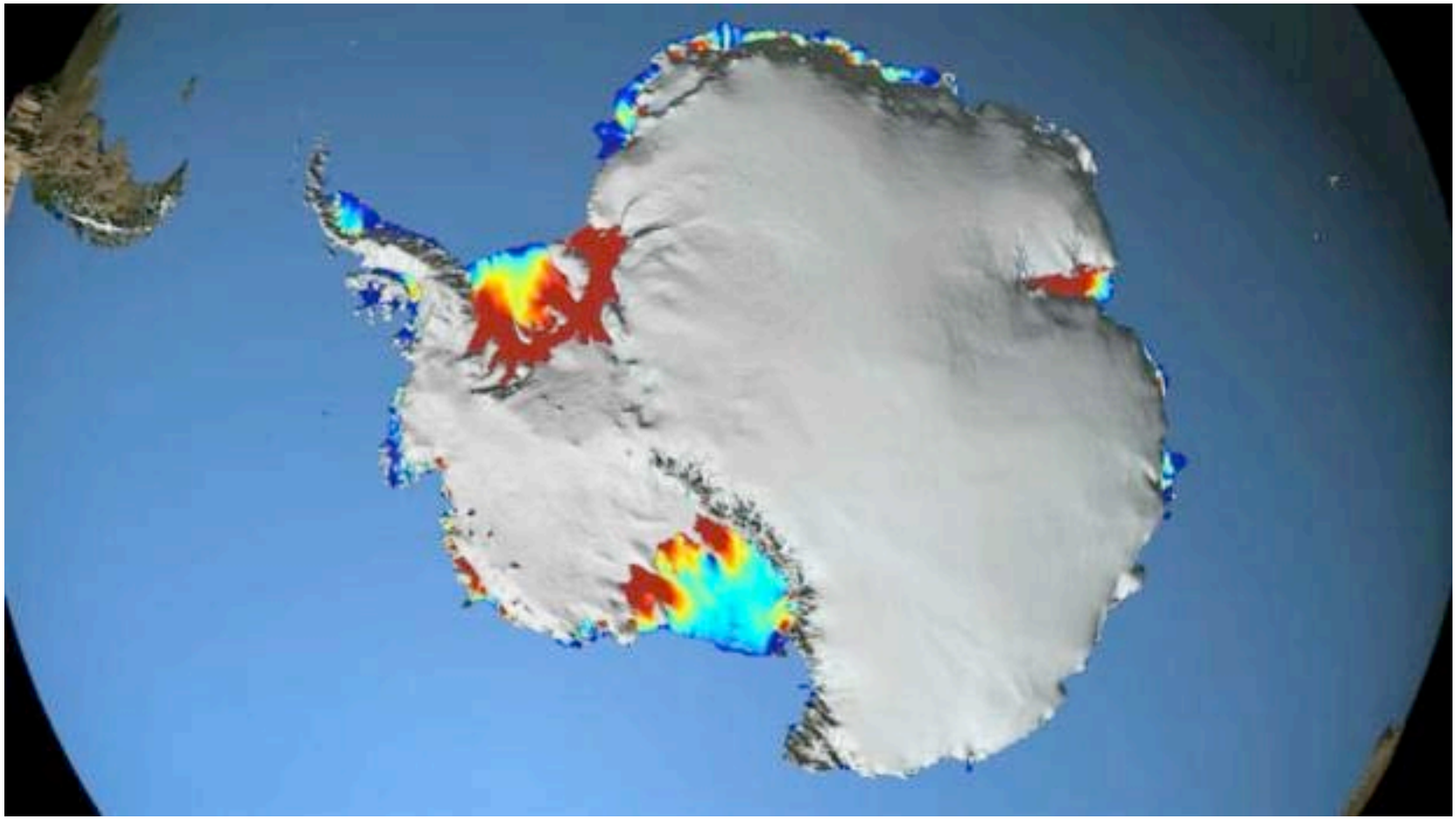
Greenland Total Melt Area –
2007 value exceeds last maximum by 10%



Antarctic Ice



Antarctic Sea Ice



“West Antarctic Ice Sheet melt is unstoppable and collapse is inevitable”
NASA, 12 May 2014

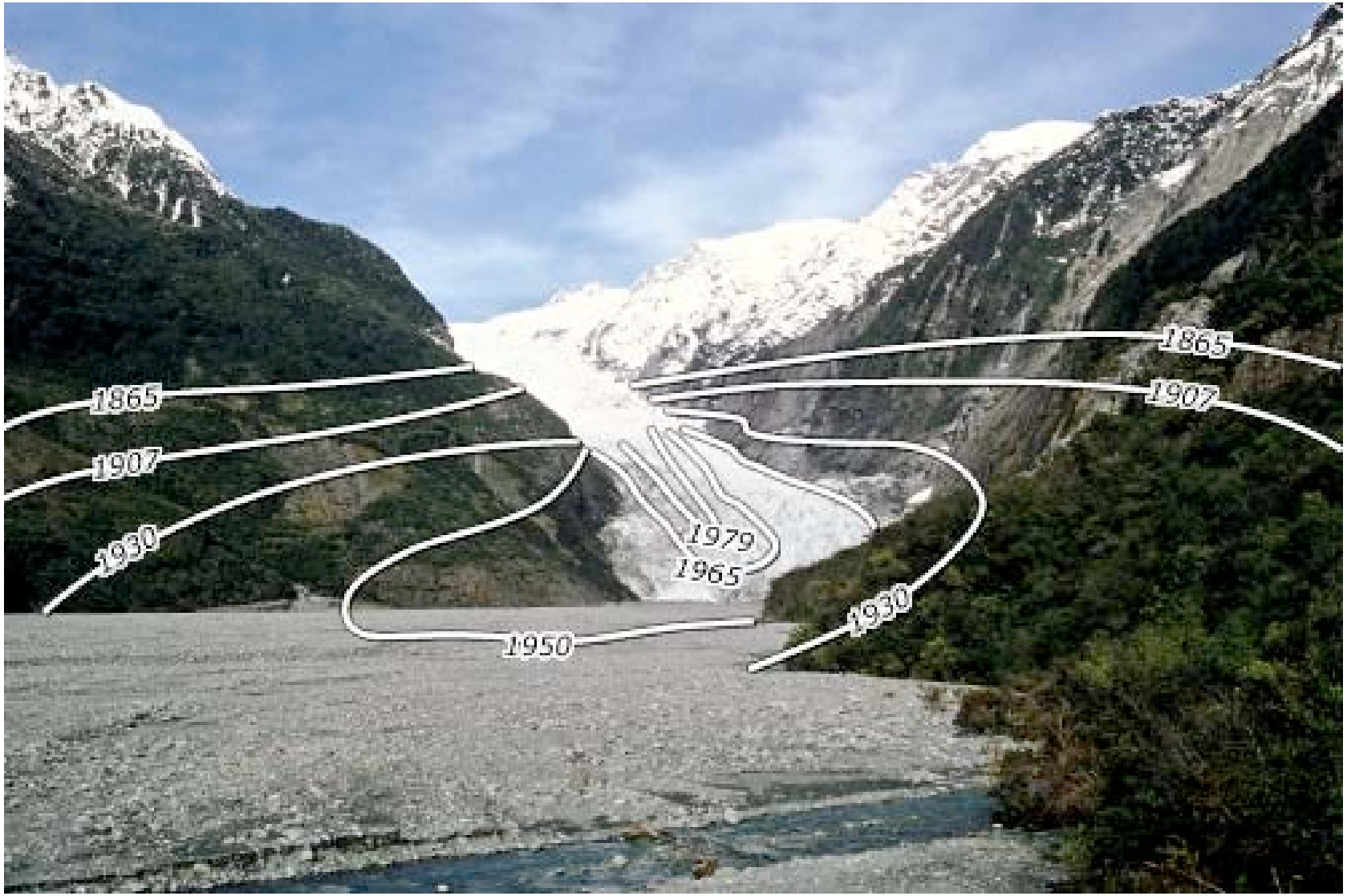
Brian’s holiday snaps

Tabular icebergs

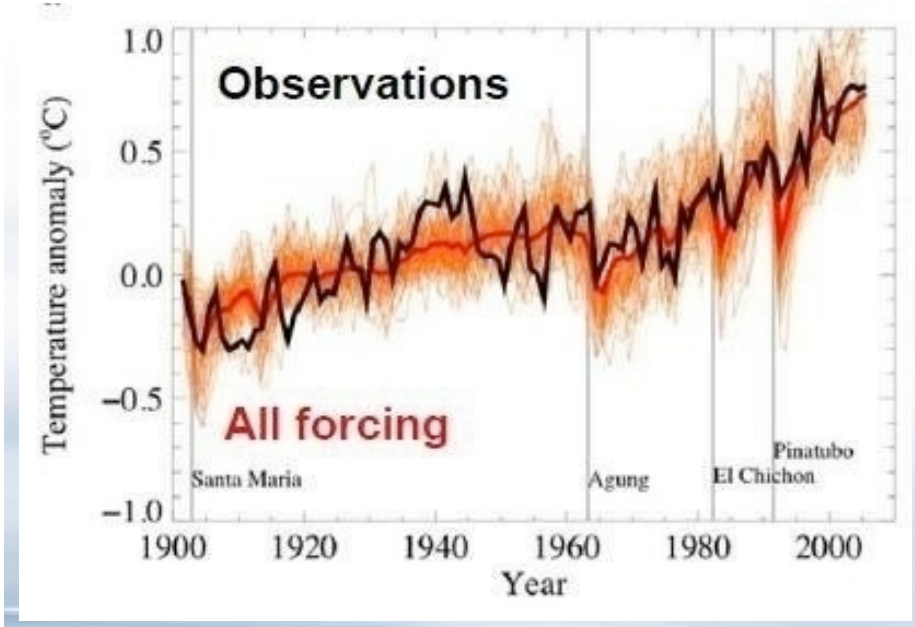
South Georgia Island

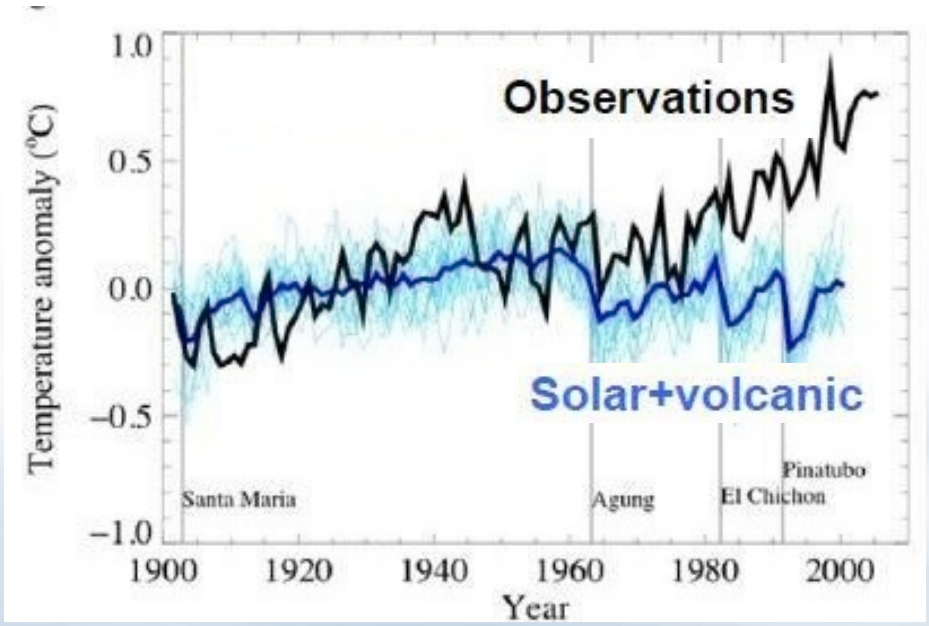

Bertrab glacier extended to coast in 1958

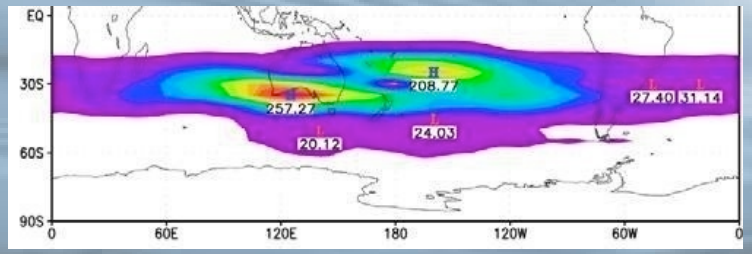
Fox Glacier, New Zealand

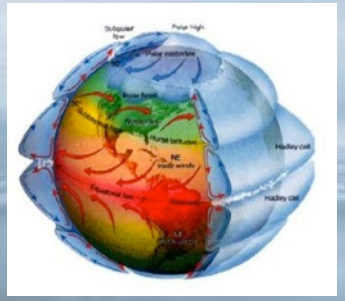


Modelling Confirms Human Impact









Source: IPPC4, WG1

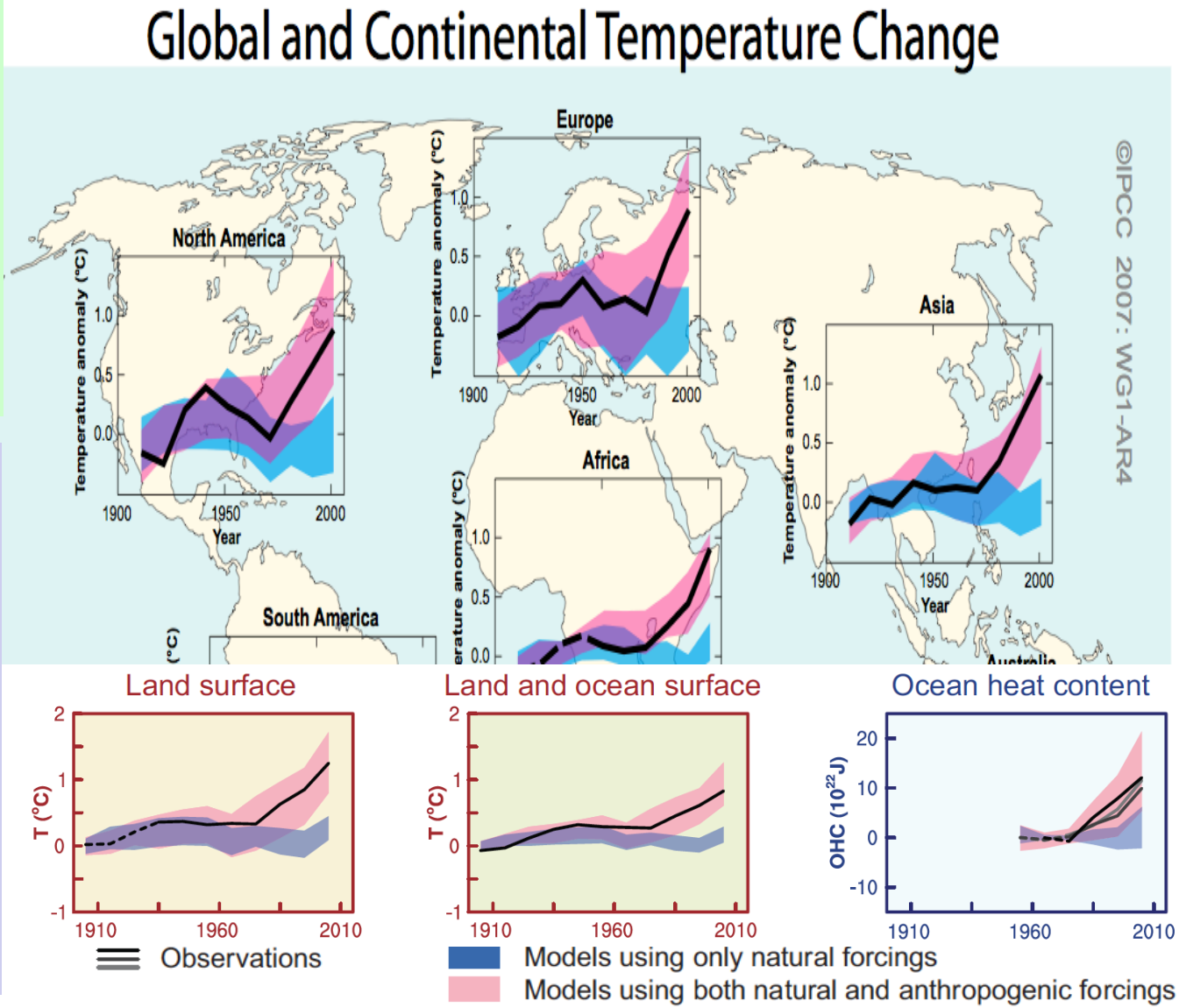
Understanding and Attributing Climate Change

"Global warming ***very likely*** shows a significant anthropogenic contribution over the past 50 years"

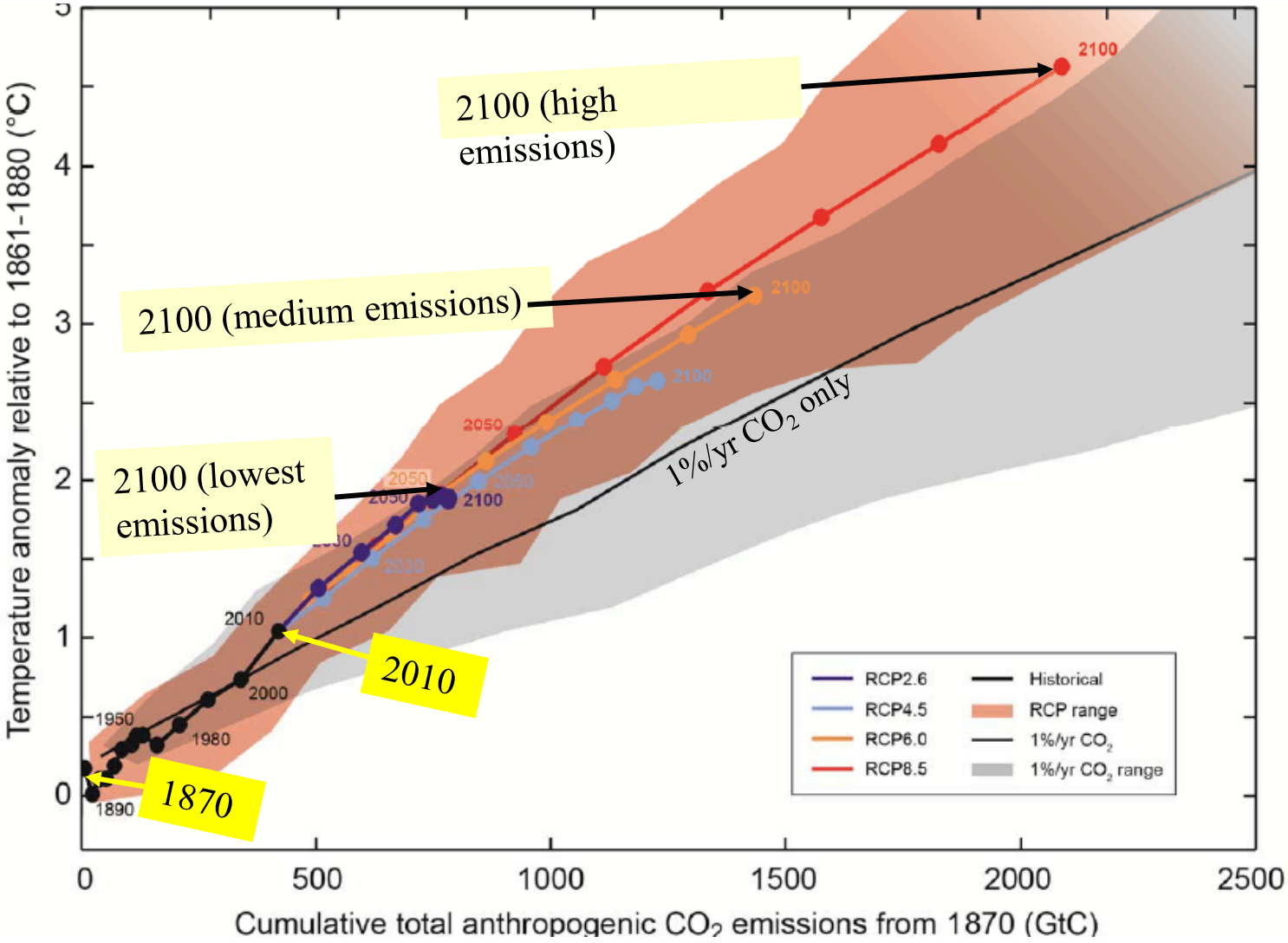
... IPCC AR4 2007

"It is ***extremely likely*** that human influence has been the dominant cause of the observed warming since the mid-20th century"

... IPCC AR5 2013



Global mean temperature increase

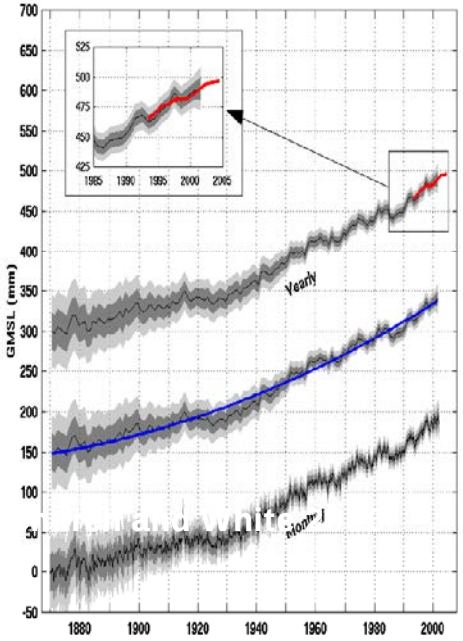


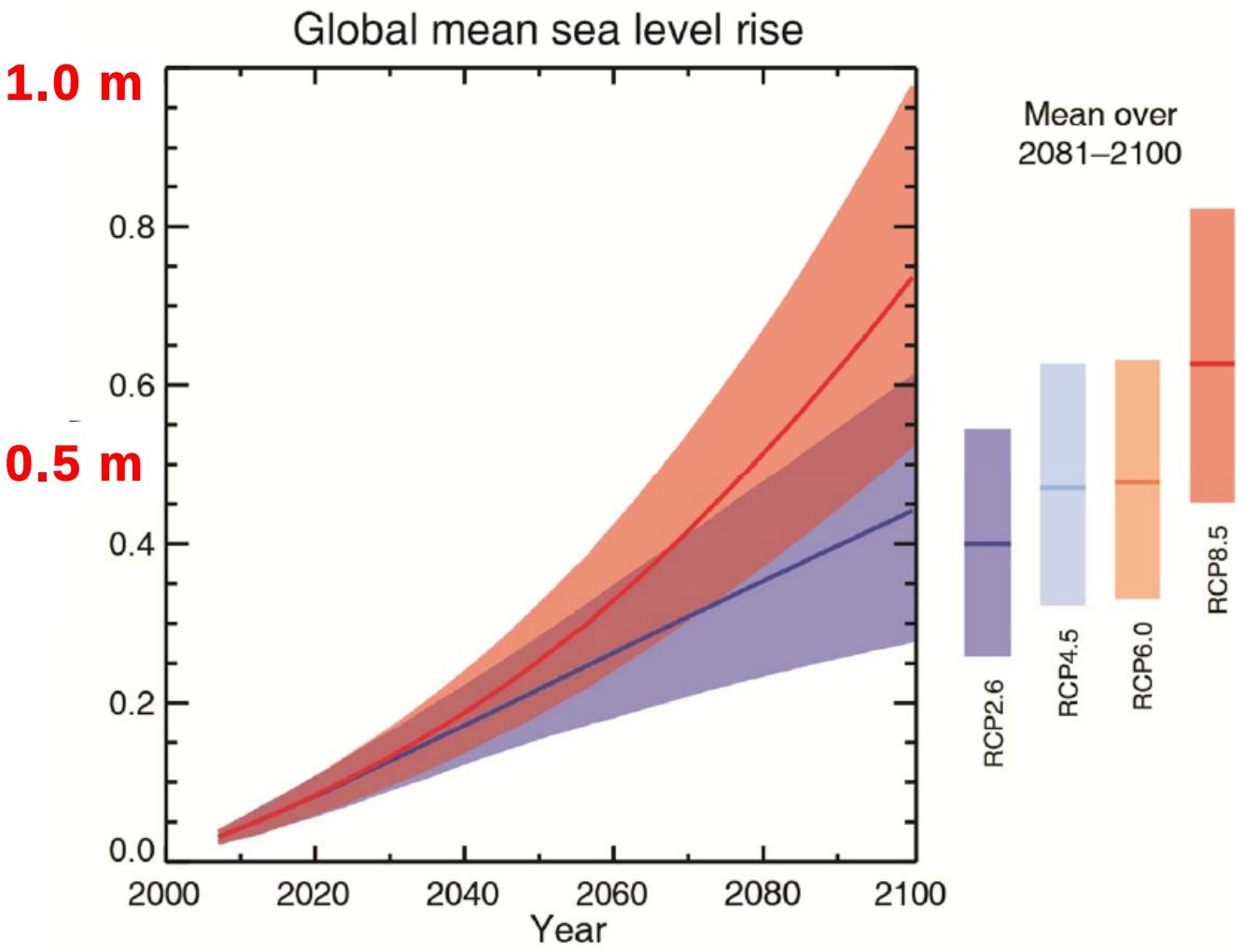
Half the CO_2 emitted stays in the atmosphere and lasts 50-100 years

Source: IPCC AR5

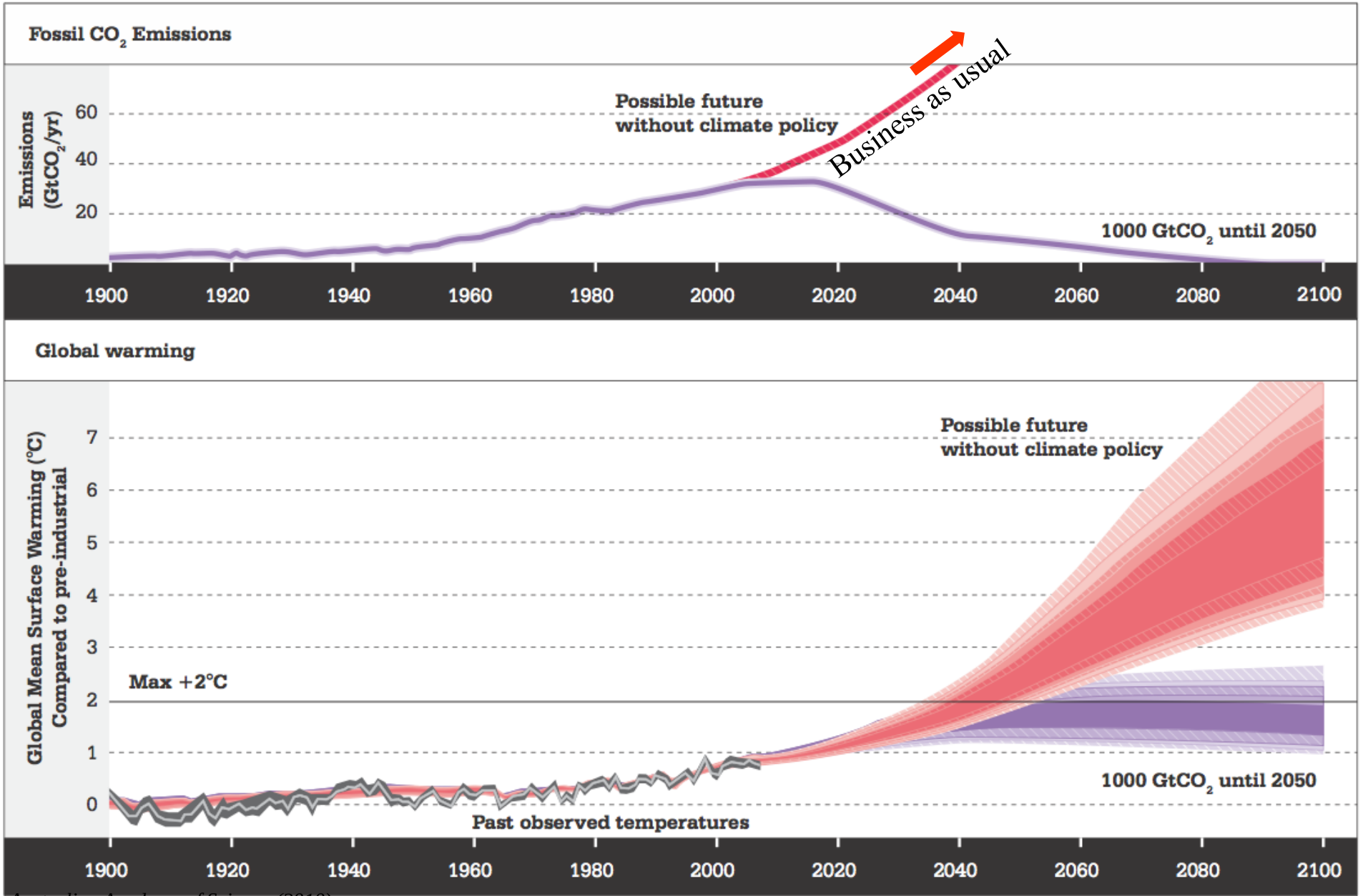
Sea-level rise is accelerating

Faster Sea-level Rise



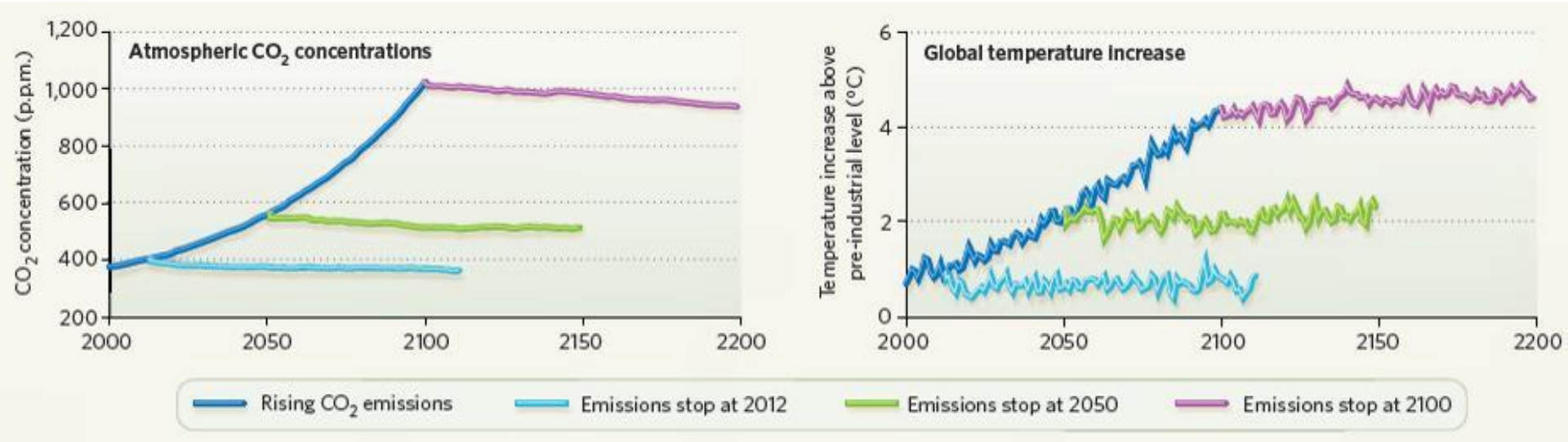


Projections of future changes in climate



How fast can earth respond?

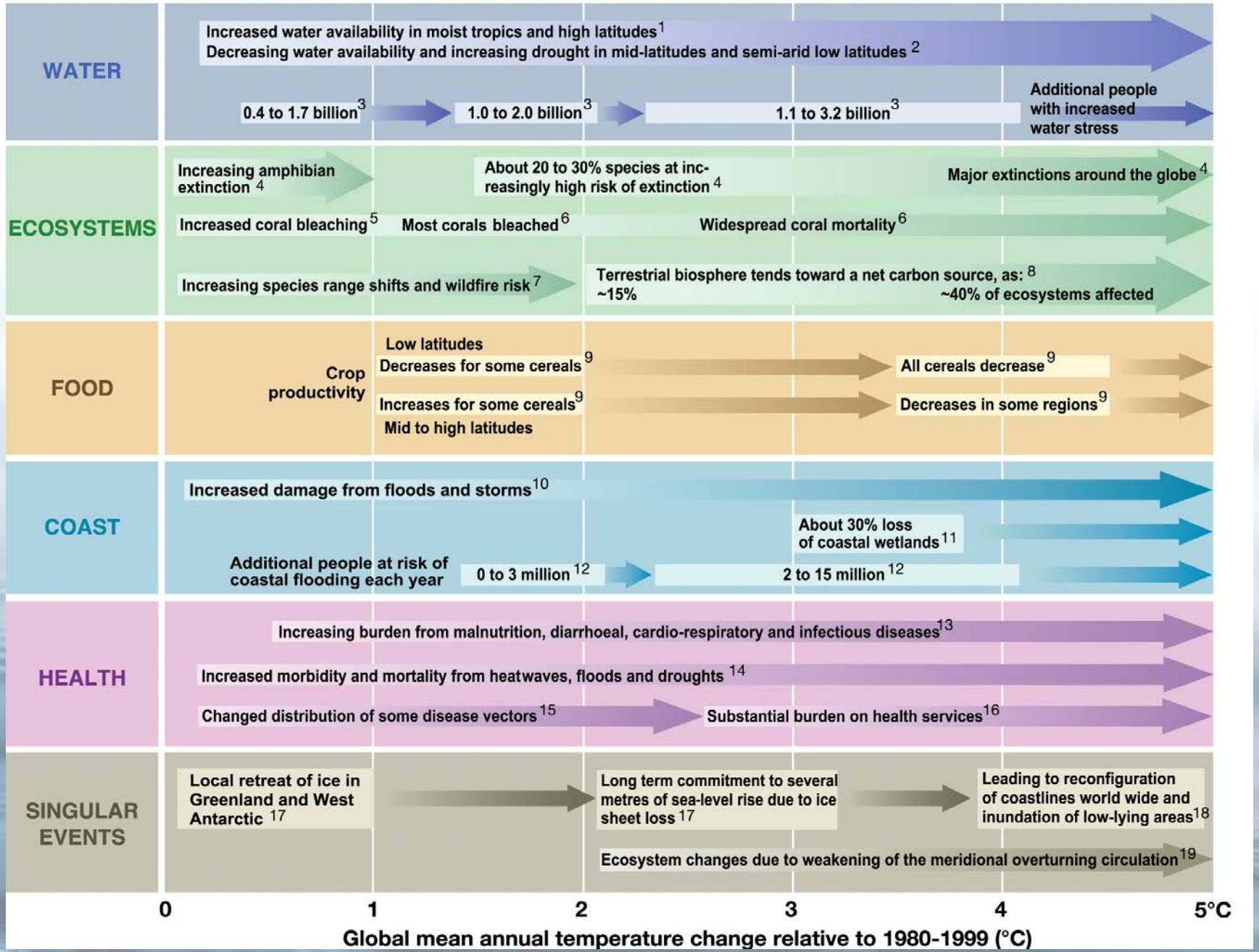
What if emissions stopped instantly? Projections for 2012, 2050 and 2100

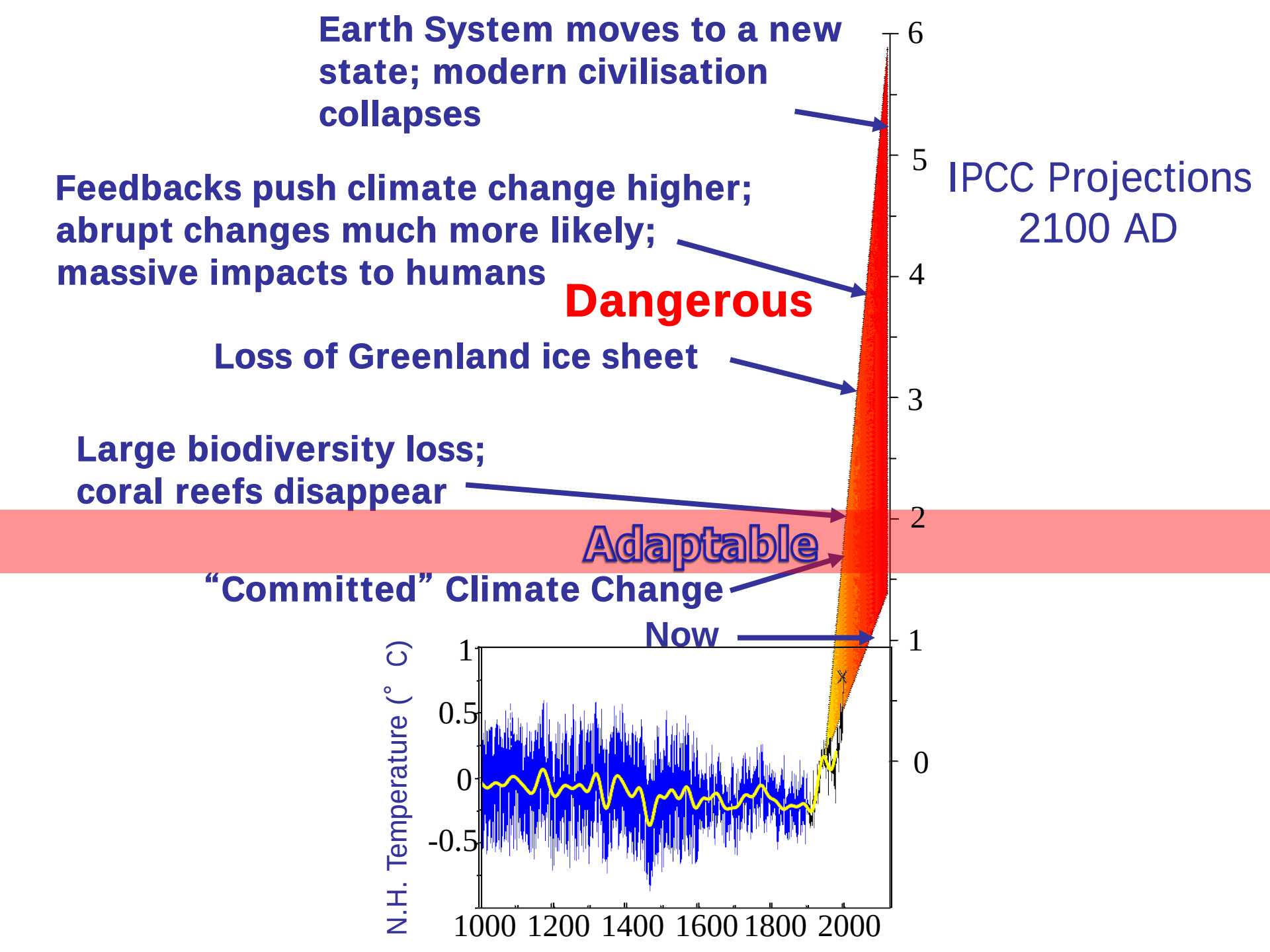


"The climate change that takes place due to increases in carbon dioxide concentration is largely irreversible for 1,000 years after emissions stop"

Susan Solomon 2009, Irreversible climate change due to carbon dioxide emissions: PNAS

Key impacts with increasing temperatures




Earth System moves to a new state; modern civilisation collapses
Feedbacks push climate change higher; abrupt changes much more likely; massive impacts to humans
Dangerous
Loss of Greenland ice sheet
Large biodiversity loss; coral reefs disappear
Adaptable
"Committed" Climate Change
Now
IPCC Projections 2100 AD
6
5
4
3
2
1
0
N.H. Temperature (° C)
1
0.5
0
-0.5
1000 1200 1400 1600 1800 2000

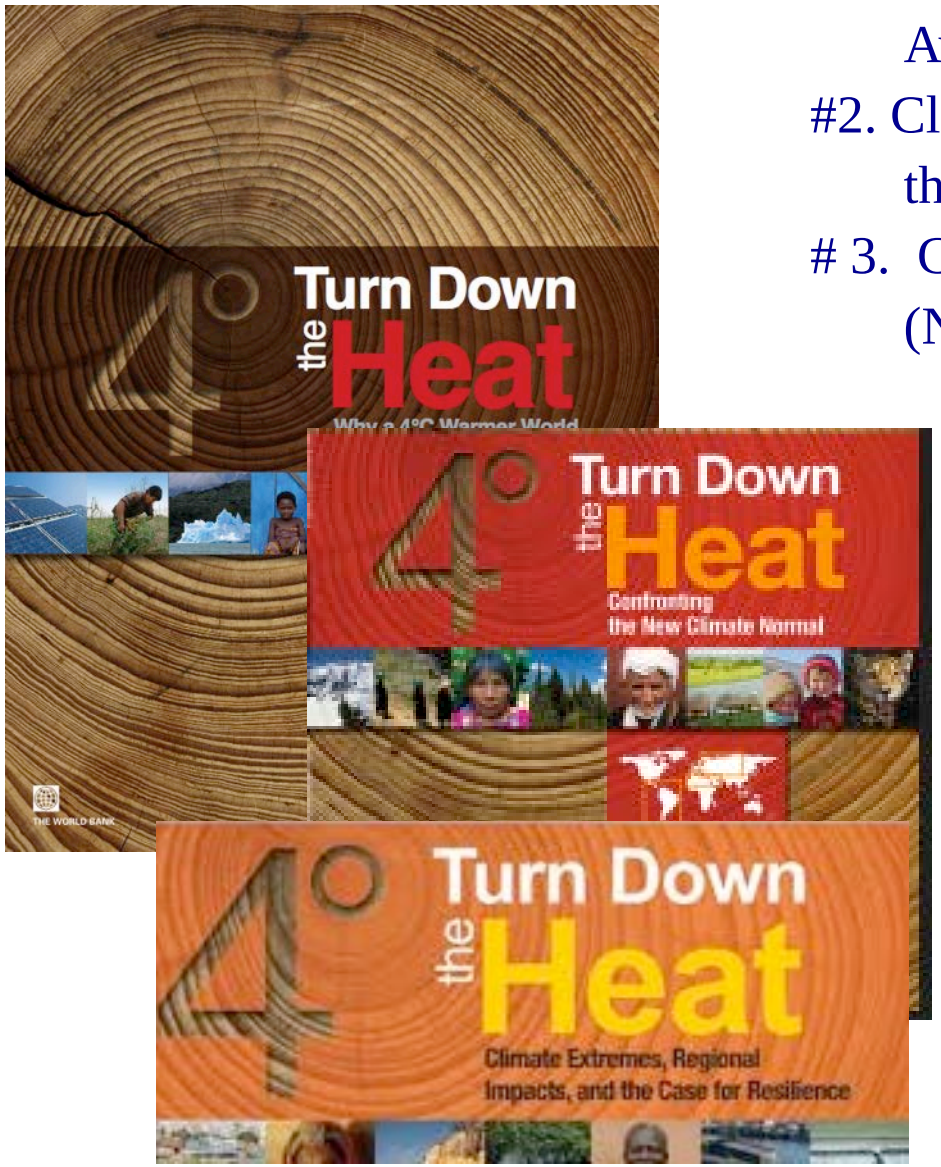
THE WORLD BANK
IBRD · IDA

Turn Down the Heat

#1. Why a 4° C Warmer World Must be Avoided (Nov 2012)

#2. Climate Extremes, Regional Impacts, and the Case for Resilience (June 2013)

3. Confronting the New Climate Normal (Nov 2014)

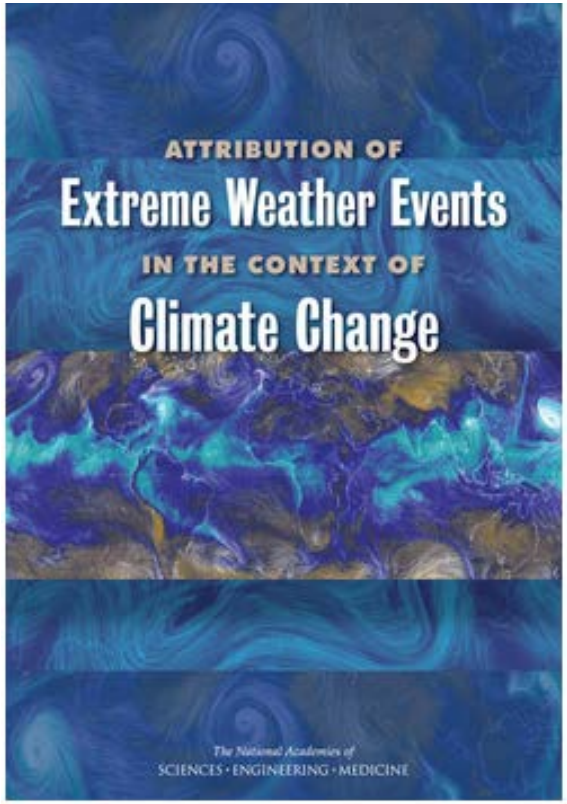


"The world is locked into about 1.5° C warming and risks are rising.

Everyone will feel the impact, particularly the poor, as weather extremes become more commons and risks to food, water, and energy security increase.

We cannot continue down the current path of unchecked, growing emissions."

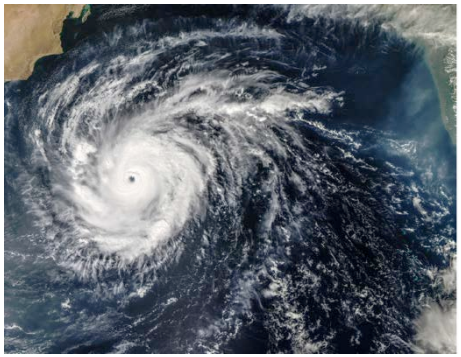
Attribution of Extreme Weather Events
National Academies Press (2016)

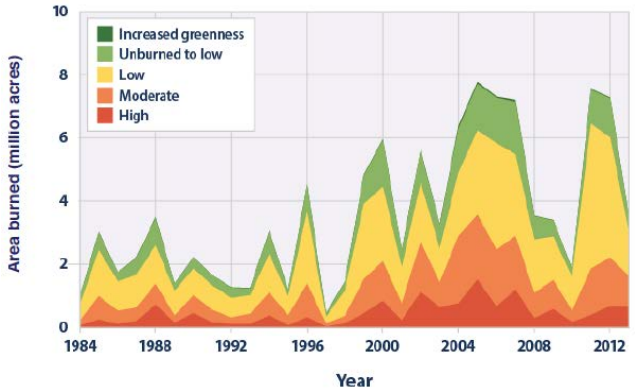


As climate has warmed over recent years, a new pattern of more frequent and more intense weather events has unfolded across the globe.

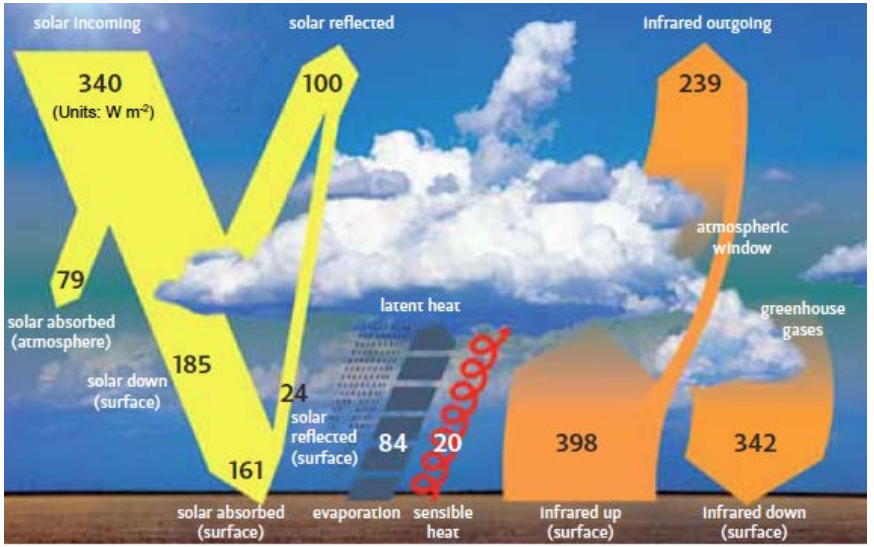
Global warming:

- Increases the likelihood of extremely hot days and nights,
- Favors increased atmospheric moisture that may result in more frequent heavy rainfall and snowfall, and
- Leads to evaporation that can exacerbate droughts.



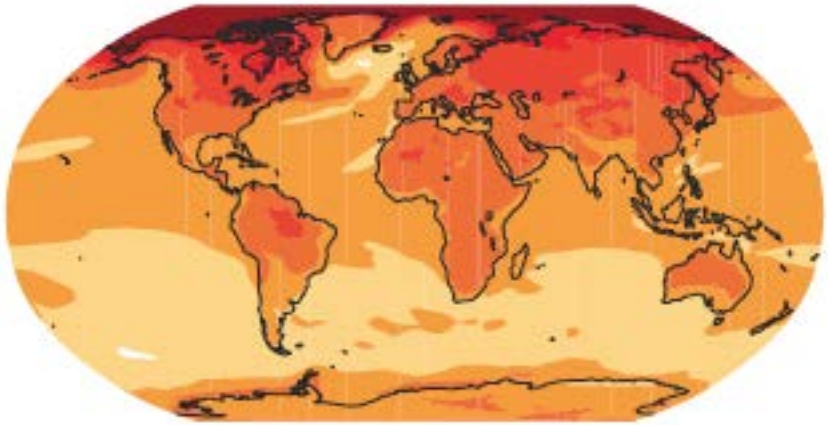


Australia Academy of Sciences



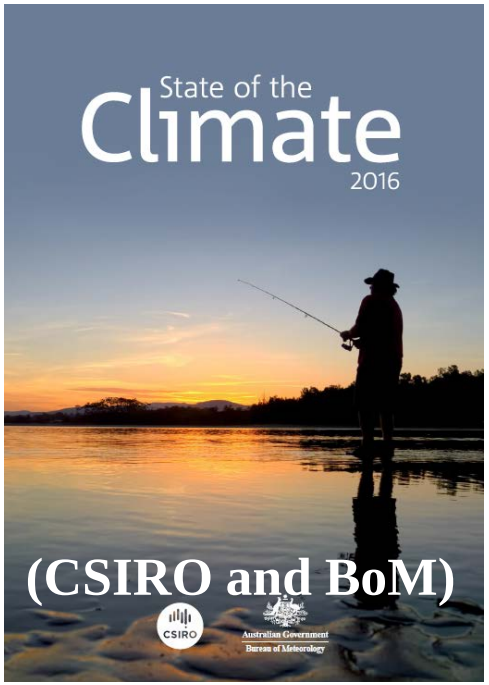
Q/A

- What is climate change?
- How has Earth's climate changed?
- Are human activities causing climate change?
- How do we expect climate to evolve in the future?
- How are extreme events changing?
- How are sea levels changing?
- What are the impacts of climate change?
- What are the uncertainties and the implications?
- What does science say about options to address climate change?

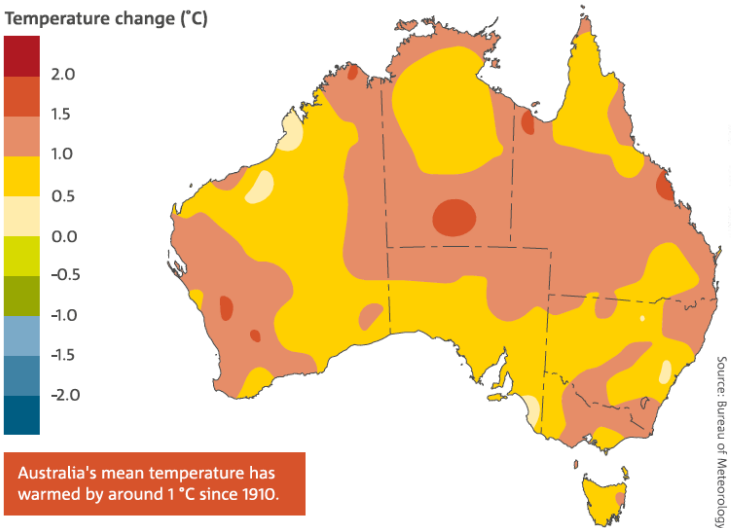


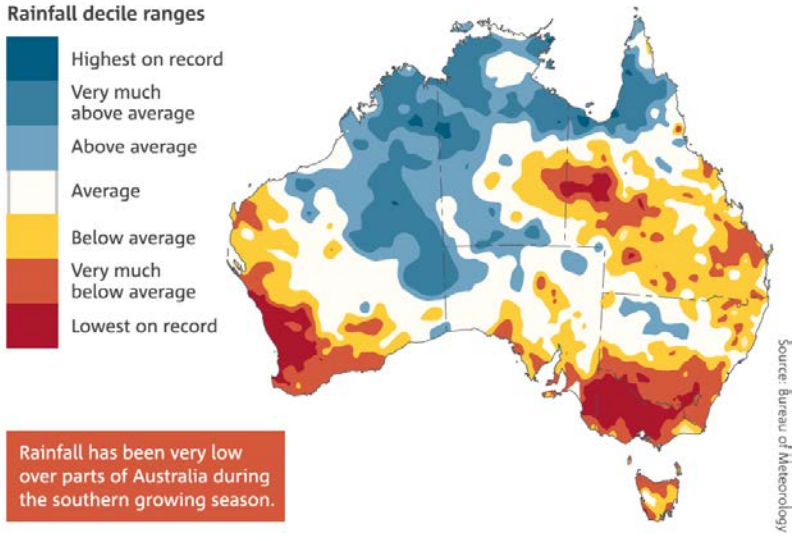
CSIRO and Bureau of Meterology

"It is extremely likely that the dominant cause of recent warming is human-induced greenhouse gas emissions and not natural climate variability"



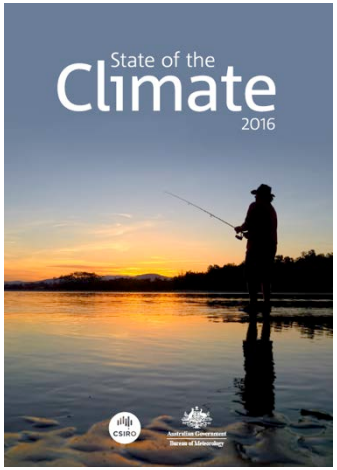
- Australia has warmed by 1.0˚ C since 1910
- Extreme fire weather increased
- Sea level rise - amplifies high tides & storm surges
- Ocean acidity has increased
- Heat stored in ocean has
- Increasing monsoonal rainfall in northern Australia
- Decrease autumn/ winter rainfall across southern Australia



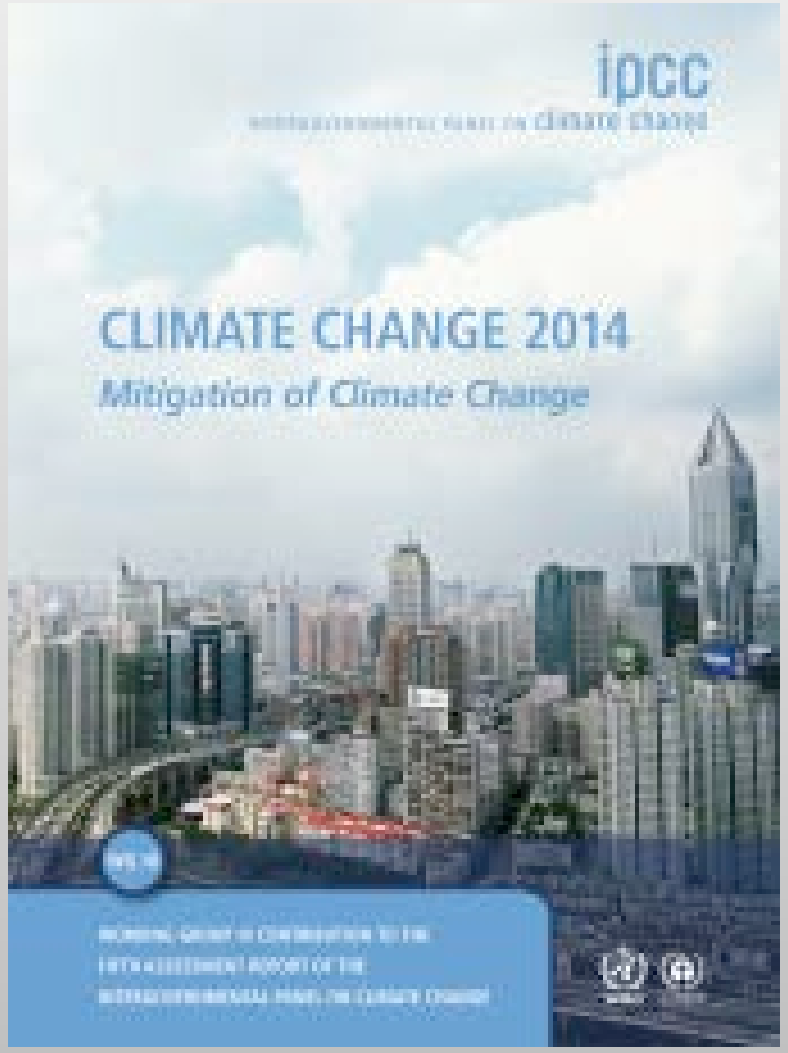


Projections for Australia

- Australian temperatures to continue to increase - more extremely hot days and fewer extremely cool days.
- The number of days with weather conducive to fire in southern and eastern Australia will increase.
- Winter and spring rainfall will decrease across southern continental Australia, with more time spent in drought.
- Past and ongoing greenhouse gas emissions mean further warming of ocean temperatures.
- Sea-level rise and ocean acidification around Australia to continue.



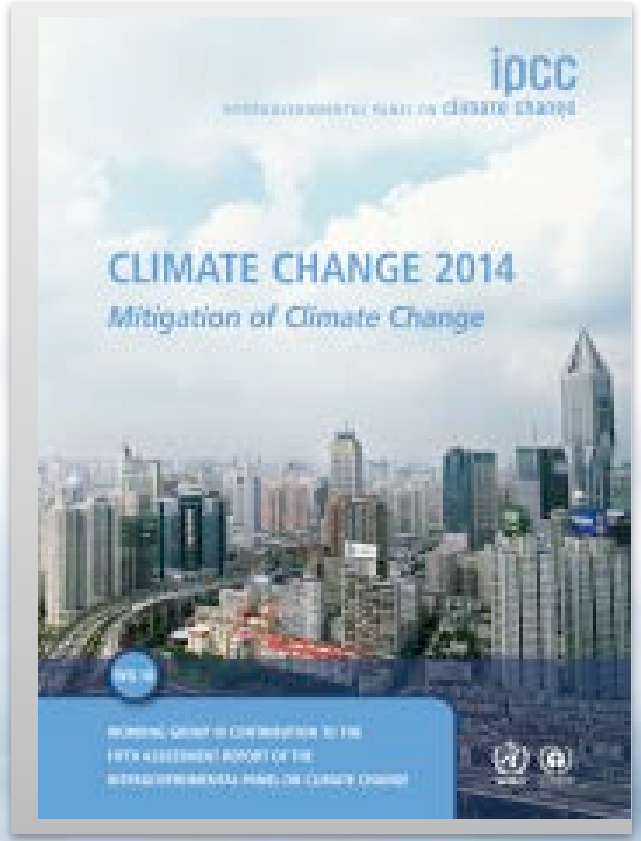
Mitigation and Adaptation



Mitigation – Action to slow climate change

- Reduce greenhouse gas emissions (primarily from fossil fuels)
- Reduce land clearing & land degradation
- Reforestation

- Mechanisms:
  - Legislation
  - Market based

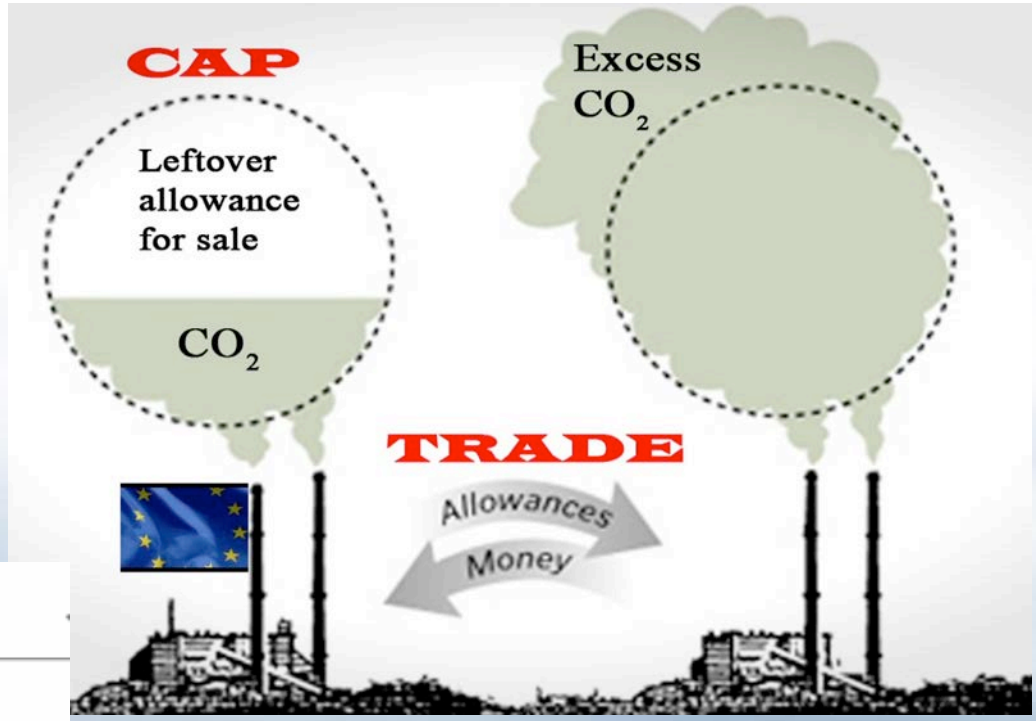


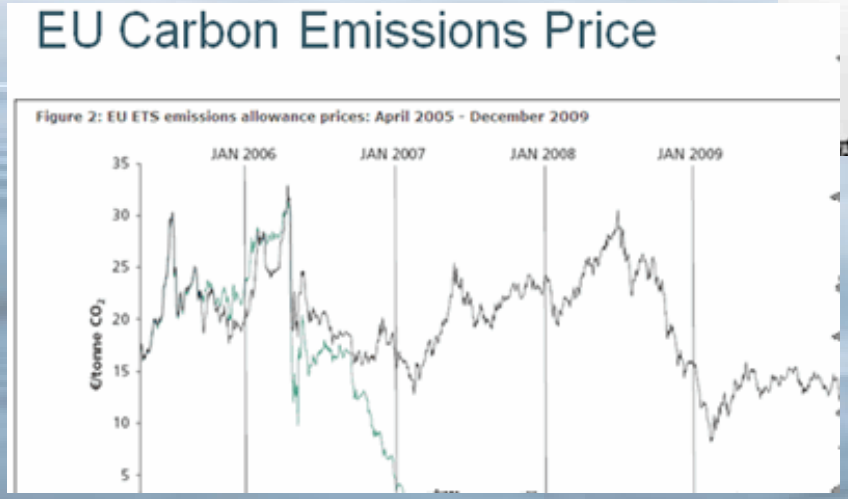
"Emissions trading" vs "direct action"

Mitigation – Action to slow climate change

Market - based

- Carbon tax
- Emission trading
- Cap and trade





ETS cheapest way to reduce emissions, says Ross Garnaut

Mitigation – Action to slow climate change

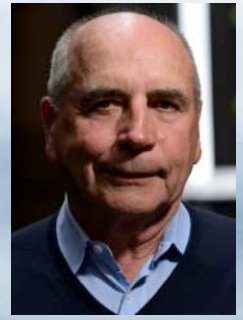
Legislation

- Mandate
- Incentives
- Penalties
- RET

Direct Action Emissions Reduction Fund (ERF) – Cash incentives via reverse auction

Renewable Energy Target (RET) – Electricity retailers source % of electricity sales from renewable energy sources

Climate Change Authority questions the efficiency and effectiveness of ERF

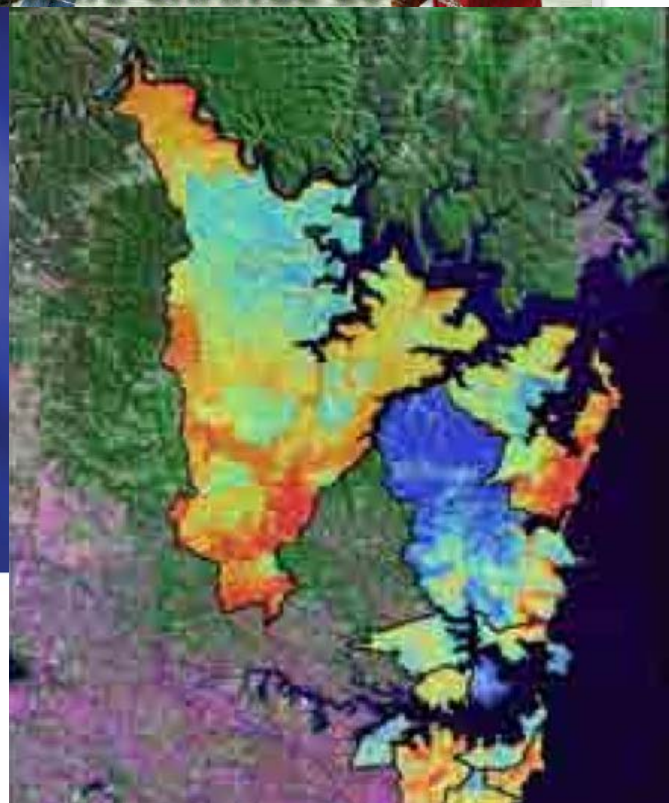


US Clean Power Plan – Electricity producers required to reduce overall carbon emissions by 32% below 2005 levels by 2030

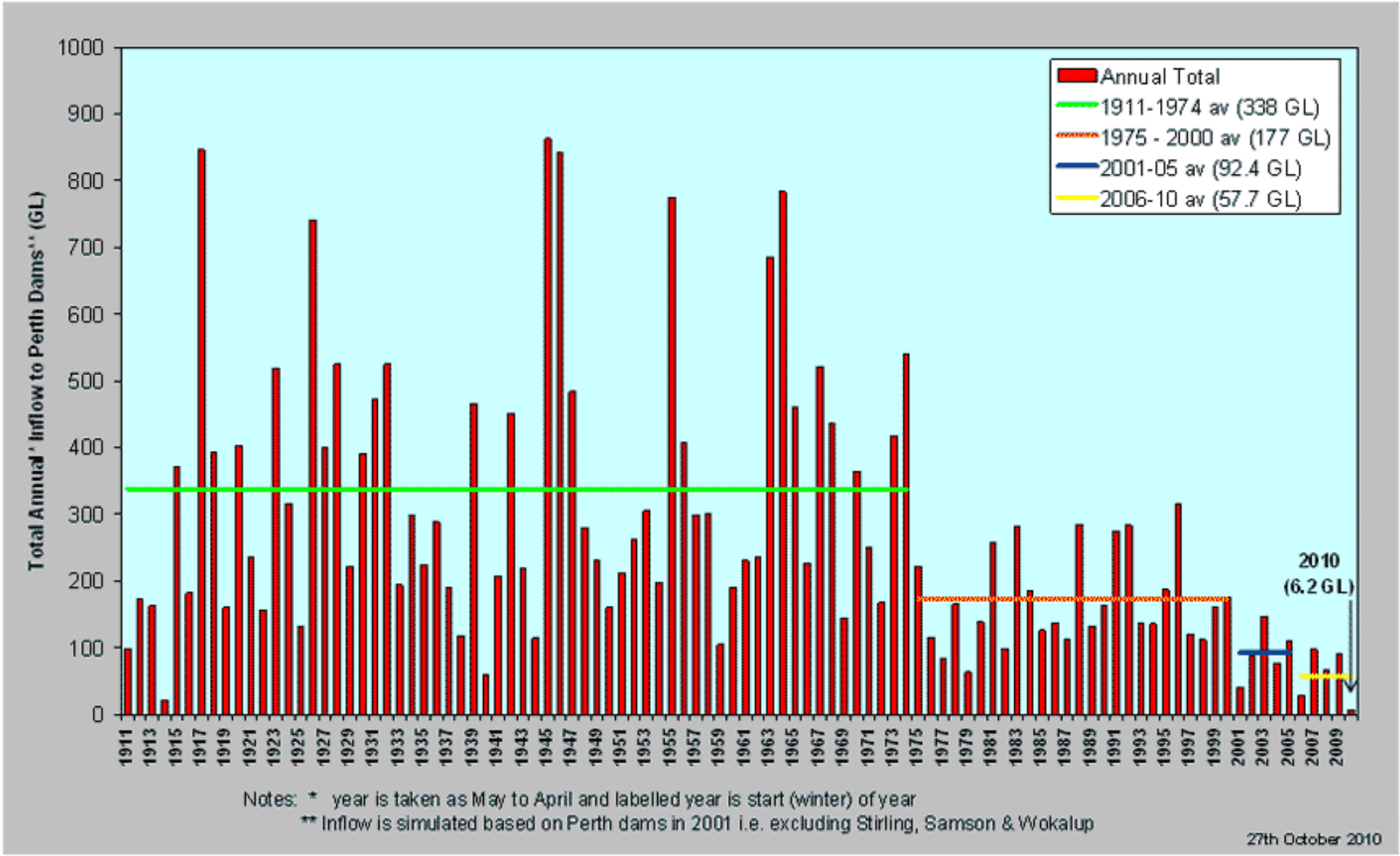
Adaptation

- Adapting to climate change

(higher temperatures, more storms, floods, rising sea levels, unreliable water supply)



Perth's inflows 1911-2010



Grain farmers bracing for epic El Nino event

Weather Grain prices rising as history points to crop failure.

Jonathan Barrett

Australia's rural sector is facing a potentially torrid end to 2015 as the threat of drought from a colossal El Nino intensifies.

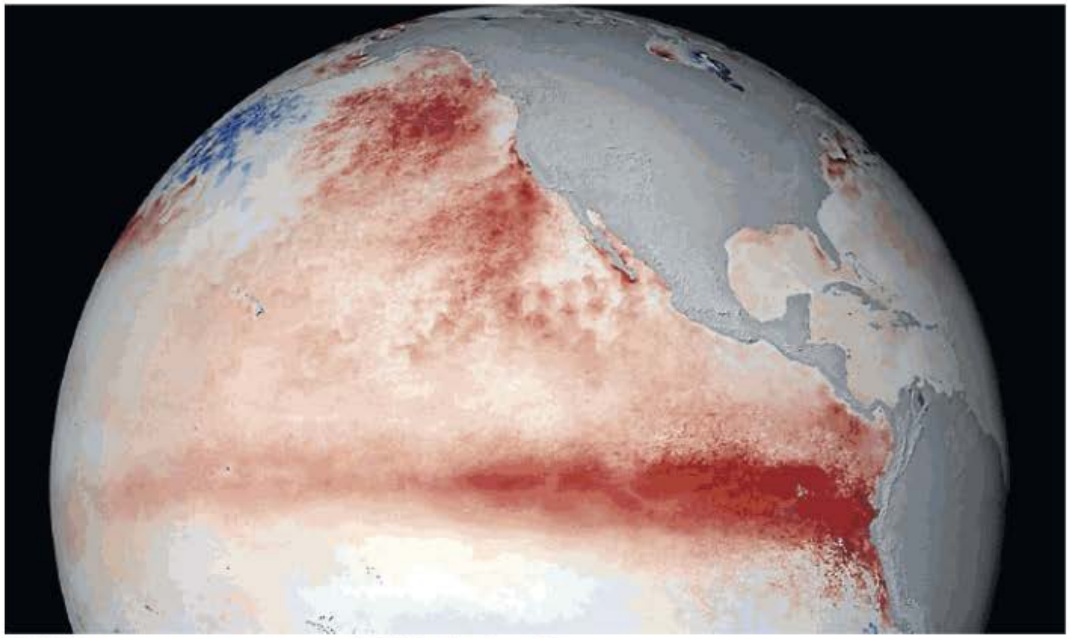
The impact of ocean current move-

growth which affected cattle. "It has huge implications," Ms Brown said.

"We've already seen bushfires. It could affect meat supply and heat stress can lead to reduced milk supply."

El Nino, which can translate as "Christ Child" in Spanish, was a name that emerged out of South America in the 1600s to describe unusually warm water in the Pacific Ocean around Christmas time.

Meteorologists would later recognise that droughts were occurring simultaneously in vastly different locations



Pacific Ocean water temperatures are at their highest in almost 20 years.

The attack on science

Climate of fear: scientists face death threats

The Canberra Times

Climate science the target in a culture war

ClimateSpectator

Like minds

Past views of three members of the panel reviewing the renewable energy target

Well I am a sceptic. I've never moved away from that. I've always been sceptical. But a sceptic is a different person than a denier. I say the science is

Dick Warburton
Manufacturing Australia chief executive in 2011

I can't see the benefit of a carbon tax, particularly in the context of Verve Energy as a generator, because it will not in any way encourage

Shirley In't Veld
Verve Energy CEO in 2012

A mandated renewable energy target is less efficient at achieving a given environmental outcome because it forces higher cost renewable energy into the electricity generation mix at the expense of exploiting

Brian Fisher
Then vice-president of CRA International, former director of ABARE

SOURCE: FINANCIAL REVIEW

Energy Abbott downplays consequences of renewables rethink

Sceptic Warburton to lead energy review

I think the climate change science is far from settled

Tony Abbott, Beaufort, Vic, 30/9/10

Greg Hunt uses Wikipedia research to dismiss links between climate change and bushfires

SMH 23/10/13

The attack on science

Andrew Bolt

Category: Global warming - propaganda

The warming scare will not die - despite the cost and the evidence - because the Left needs it

Andrew Bolt – *Saturday, June 13, 2015 (7:43am)*

Ignore Flannery: a warmer world is actually healthier

Andrew Bolt – *Thursday, April 23, 2015 (12:01am)*

See what happens when Tim Flannery makes predictions?

The Telegraph

Australia PM adviser says climate change is 'UN-led ruse to establish new world order'

Tony Abbott's business adviser says global warming a fallacy supported by United Nations to 'create a new authoritarian world order under its control'

1K 159 0 32 2K Email

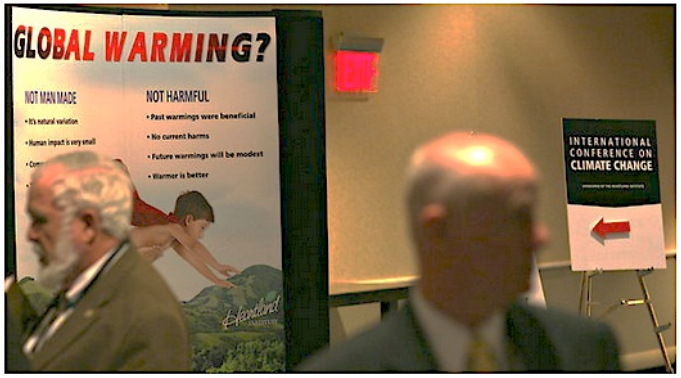
Maurice Newman, chairman of the Prime Minister's Business Advisory Council Photo: AP

The Telegraph 8 May 2015

The New York Times

Leak Offers Glimpse of Campaign Against Climate Science

By JUSTIN GILLIS and LESLIE KAUFMAN



The 2008 International Conference on Climate Change, a gathering in Times Square of skeptics on global warming. Richard Perry/The New York Times

Heartland Institute funding

Donald J. Trump ✓
@realDonaldTrump

Follow

The concept of global warming was created by and for the Chinese in order to make U.S. manufacturing non-competitive.

6:15 AM - 7 Nov 2012

103,957 65,434

THE HEARTLAND INSTITUTE
IDEAS THAT EMPOWER PEOPLE

Our MISSION

Discover, develop, promote, and empower people with free-market solutions to social and economic problems.

Spends $100,000 for spreading the message in K-12 schools that "the topic of climate change is controversial and uncertain - two key points that are effective at dissuading teachers from teaching science"

How does the public respond?

"Climate change brings a wide range of feelings – sadness, distress, shame, guilt, despair, loss, grief."
… *Susie Bourke, Australian Psychological Society*

People may react by

- **Minimising** or **denying** that there is a problem
- **Avoiding** thinking about the problem
- Being **sceptical** about the problem
- Become **desensitised** to information

If people feel they can't change a situation, they

- May become **dependent on others** (eg gov) to act
- **Resigned** ("if it happens, it happens")
- **Cynical** ("there's no way we can change things"), or
- **Fed up** with the topic

https://www.psychology.org.au/inpsych/aps_challenge/

Steady progress

The New York Times

Pope Francis, in Sweeping Encyclical, Calls for Swift Action on Climate Change

"If present trends continue, this century may well witness extraordinary climate change and an unprecedented destruction of ecosystems, with serious consequences for all of us"

Pope Francis, encyclical letter, Laudato Si': On Care for Our Common Home, 18 June 2015

"This is a good, solid economically responsible, environmentally responsible target"

The Sydney Morning Herald

Abbott government announces plan to cut emissions by 26 to 28 per cent by 2030

Two steps forward, one step back

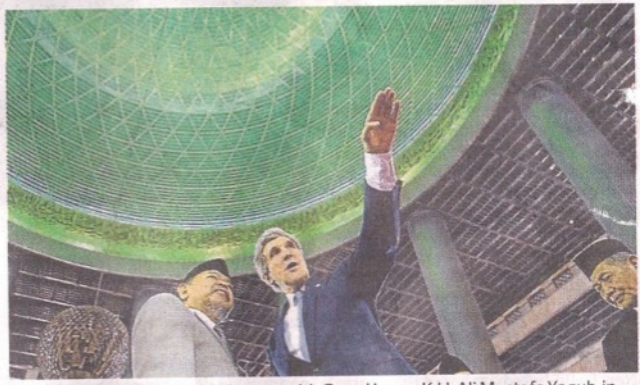
US Secretary of State, John Kerry, 16/2/14

Those who do not accept that human activity causes global warming are "shoddy scientists" and "extreme ideologues" .. Big companies and special interests should not be allowed to "hijack" the climate debate

US and China join hands to address climate change

ital of Jakarta on Saturday, where he is scheduled to give a speech on Sunday urging the country to do more to tackle

reaffirm their commitment to contribute significantly to successful 2015 global efforts to meet this challenge."



John Kerry tours the Istiqlal Mosque with Grand Imam K.H. Ali Mustafa Yaqub in Jakarta on Sunday. PHOTO: REUTERS

17/2/14

Climate change: Greg Hunt backs Coalition policy after IMF chief Christine Lagarde urges Australia to remain 'pioneers'

15/2/14

The road to Paris

The New York Times

Obama Says World Must Reach Climate Deal in Paris 'While We Still Can'

"This year, in Paris, must be the year that the world finally reaches an agreement to protect the one planet we've got while we still can…

Global Climate Pact Gains Momentum as China, U.S. and Brazil Detail Plans

India Vows to Cut Carbon Intensity in Paris Pledge

2015 Paris Climate Conference

- COP 21: 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change: 40,000 participants
- Mitigation efforts to take into account the needs and capacities of each country

→A universal, legally binding agreement between governments to combat climate change effectively and boost the transition towards resilient, low-carbon societies and economies

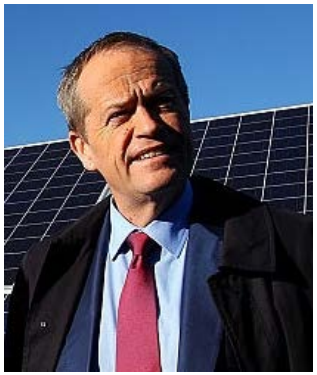
→Agreed to keep global warming below 2° C … and pursue efforts to limit temperature increase to 1.5 degrees

→Five-yearly cycles of emissions reduction pledges from 2020

COP21 = Net zero emissions by 2050-2080

"Paris is…a step along the way to achieving a net zero-emissions world.''
– *Prime Minister Malcolm Turnbull*

"The first, long-term objective Labor pledges itself to today, is for Australia to achieve net zero pollution by 2050."
– *Opposition Leader Bill Shorten*

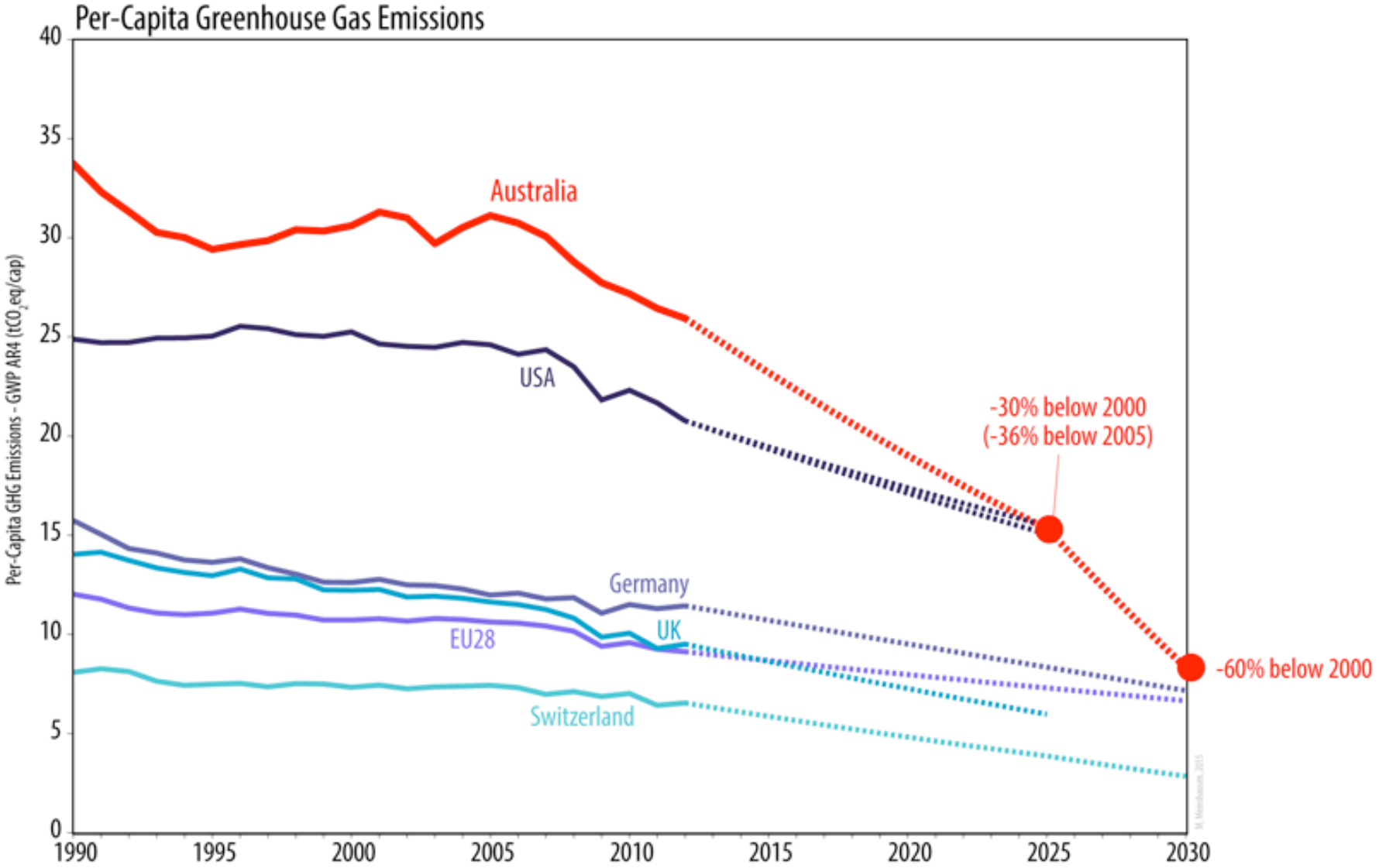


"<2° C will require … most countries including Australia eventually reducing net greenhouse gas emissions to zero or below."
- *Australian Climate Roundtable*

Australia Ratifies Paris Agreement

The 2015 agreement came into force 4 Nov 2016, ratified by 103 countries and covering 70 per cent of global emissions.

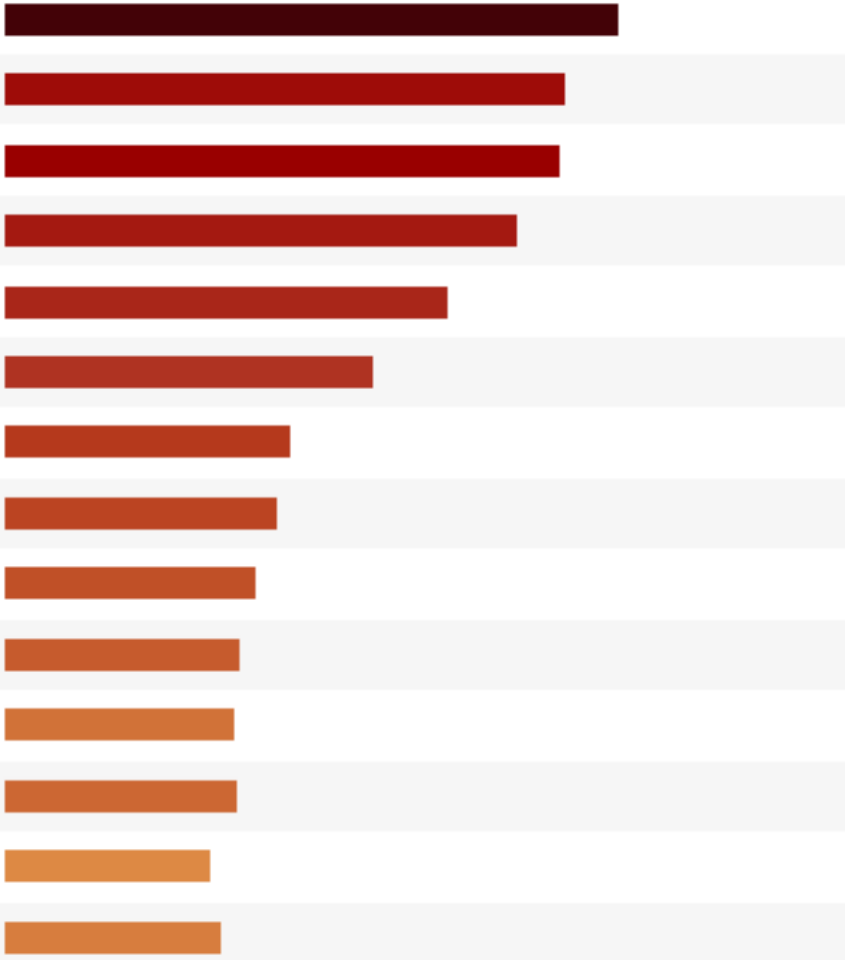
How do we compare?



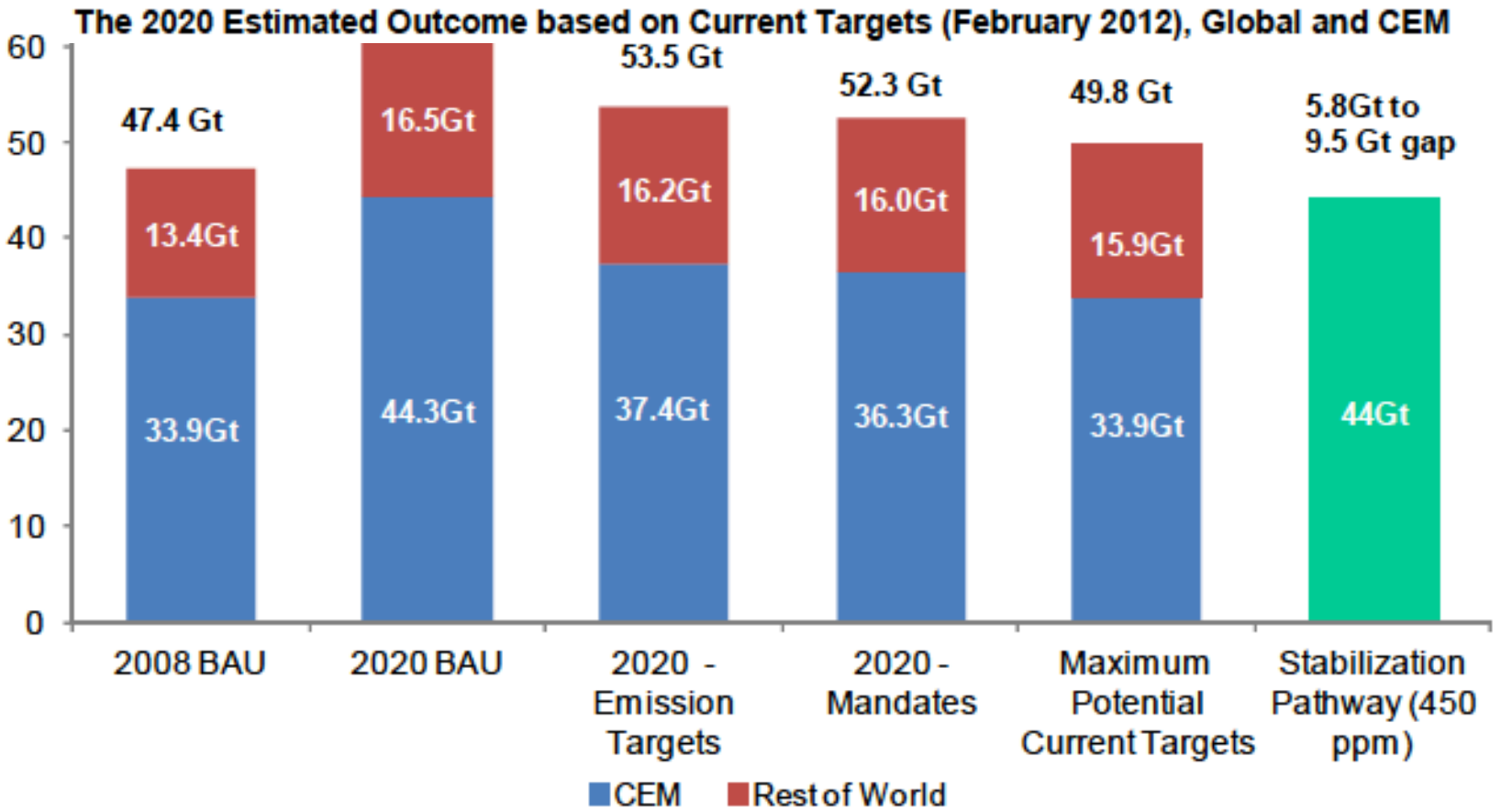
Source: Annabelle Workman, Univ Melbourne

How do we compare?

Country	Total CO_2 emissions per capita
Australia	28.52
Canada	20.55
USA	19.86
Saudi Arabia	18.63
Russian Federation	16.22
Korea, Rep. (South)	13.87
Germany	11.03
Japan	10.54
Iran	9.36
South Africa	8.84
United Kingdom	8.69
Ukraine	8.56
China	8.13
Italy	7.81



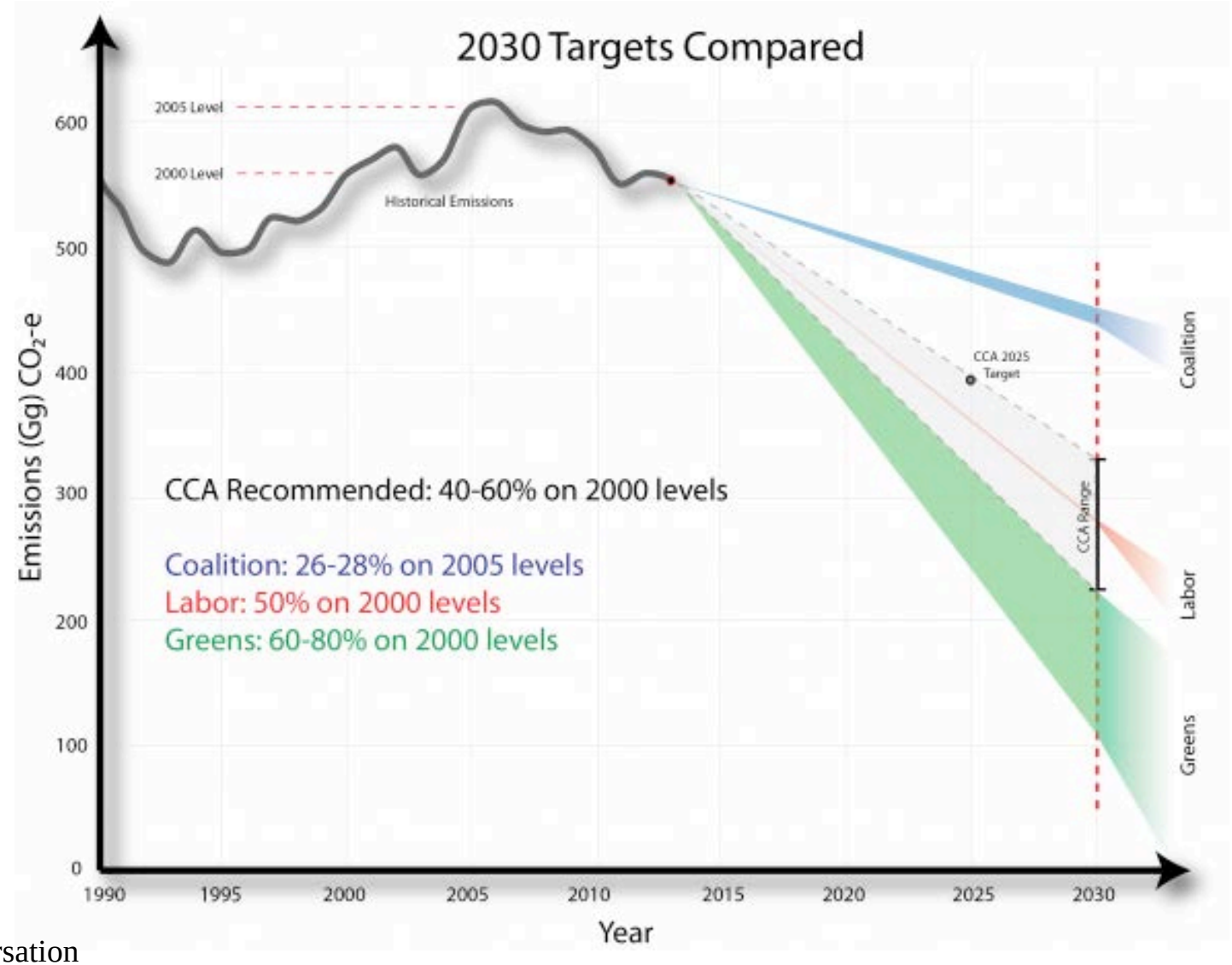
Still not enough



None of these will meet the 450ppm 2020 target for 2°c

Source: Global climate change policy tracker 2012, Deutsche Bank

My cut is bigger than yours



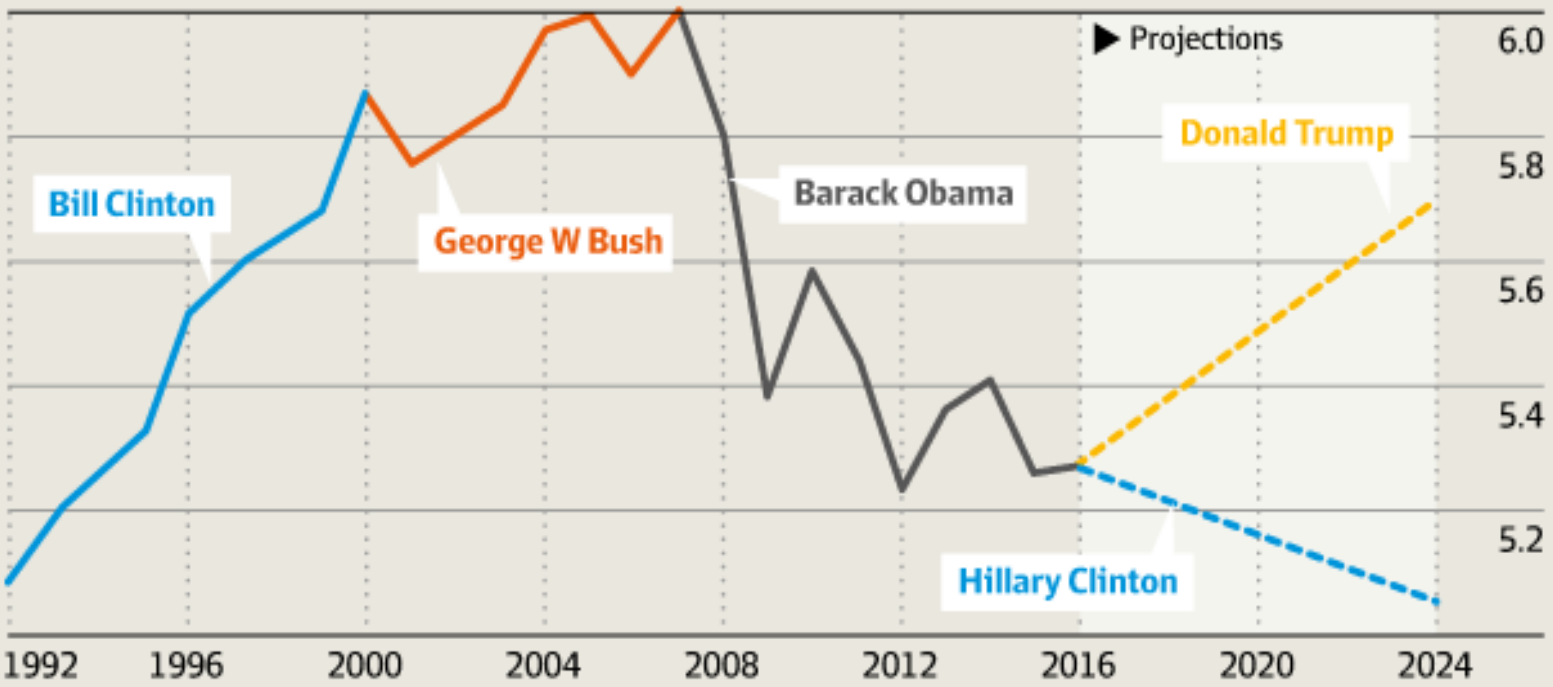
The Conversation

What will the USA do?

Election result fires up climate fears

Trump getting warmer

US CO_2 emissions (gigatonnes)



Angela Macdonald-Smith AFR, 11 Nov 2016

Marrakesh

Steely determination brings progress at Marrakesh climate talks

"The U.S. presidential election sent reverberations through the gathering, but it did not deter participants from moving forward with a spirit of determination.

"Over 190 governments agreed to the Marrakech Action Proclamation which sent a strong message of global unity on climate change.

THOMSON REUTERS FOUNDATION NEWS

21 Nov 2016

No longer “Business as Usual”

Breaking the tragedy of the horizon - climate change and financial stability

Mark Carney,
Governor, Bank of England,
29 Sep 2015

“Climate change will threaten financial resilience and longer-term prosperity.

“While there is still time to act, the window of opportunity is finite and shrinking.

“We can build a virtuous circle of better understanding of tomorrow’s risks, better pricing for investors, better decisions by policymakers, and a smoother transition to a lower-carbon economy.”

Business imperatives

Jeremy Bentham (Shell): “We have to ensure that we remain an attractive investment for shareholders”

… *A Better life with a Healthy Planet – Pathways to Net-Zero Emissions*

Business Council of Australia

Energy and Climate Change

Australian Government

Department of the Environment and Energy

Carbon neutral certified organisations, products and services

sba

Sustainable Business Australia

Australian CEO guide to CLIMATE ACTION

sba

Australian National University

Policy: Socially responsible investment

Australia is falling behind

"Australia is falling behind when it comes to addressing the financial risks of climate change."

Paul Fisher
Chair, G20 Financial Stability Board
20 Oct 2016

"I saw climate change go from being an issue that was sociopolitical, ethical, moral if you like, to being front and centre as a hard commercial issue"

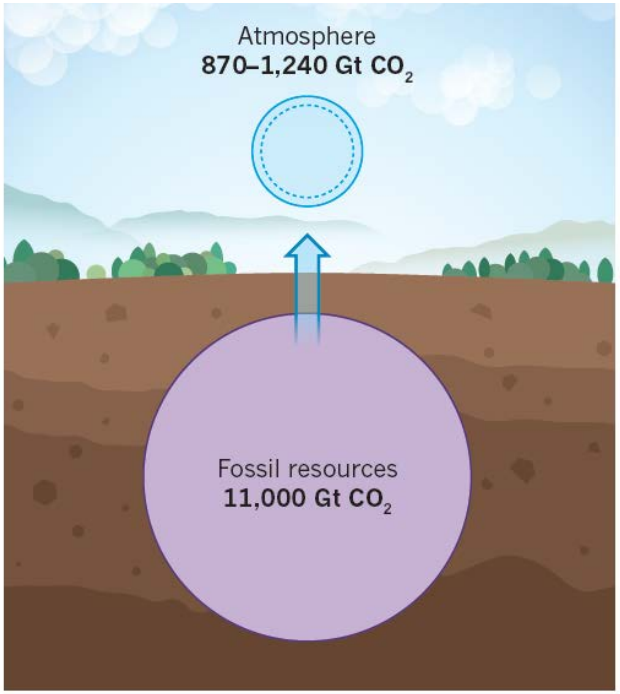
"We need to sweep the politics to one side and say this is just a commercial business risk, like any other, that we need to take into account. It's coming, and ignoring it or pretending it isn't there is not going to help.

The end of coal?

CLIMATE SCIENCE

Unburnable fossil-fuel reserves

How much more of Earth's fossil fuels can we extract and burn in the short- to medium-term future and still avoid severe global warming? A model provides the answer, and shows where these 'unburnable' reserves are. SEE LETTER P.187



90% of Australian coal must stay in the ground

Jakob & Hilaire, Nature 2016; Harvard Project on Climate Agreements

The end of coal?

fr.com | The Australian Financial Review 25

FINANCIAL TIMES ft.com

JPMorgan chokes off finance for new coal mines, projects

Pilita Clark

London | JPMorgan Chase, one of the world's biggest banks, is to stop direct financing of all new coal mines and coal power plants in rich countries in the wake of the global climate accord agreed in Paris in December.

The US bank has included coal projects alongside child labour on a list of "prohibited transactions" in the new version of its environmental and social policy published on its website.

"We believe the financial services sector has an important role to play as governments implement policies to combat climate change," the policy says.

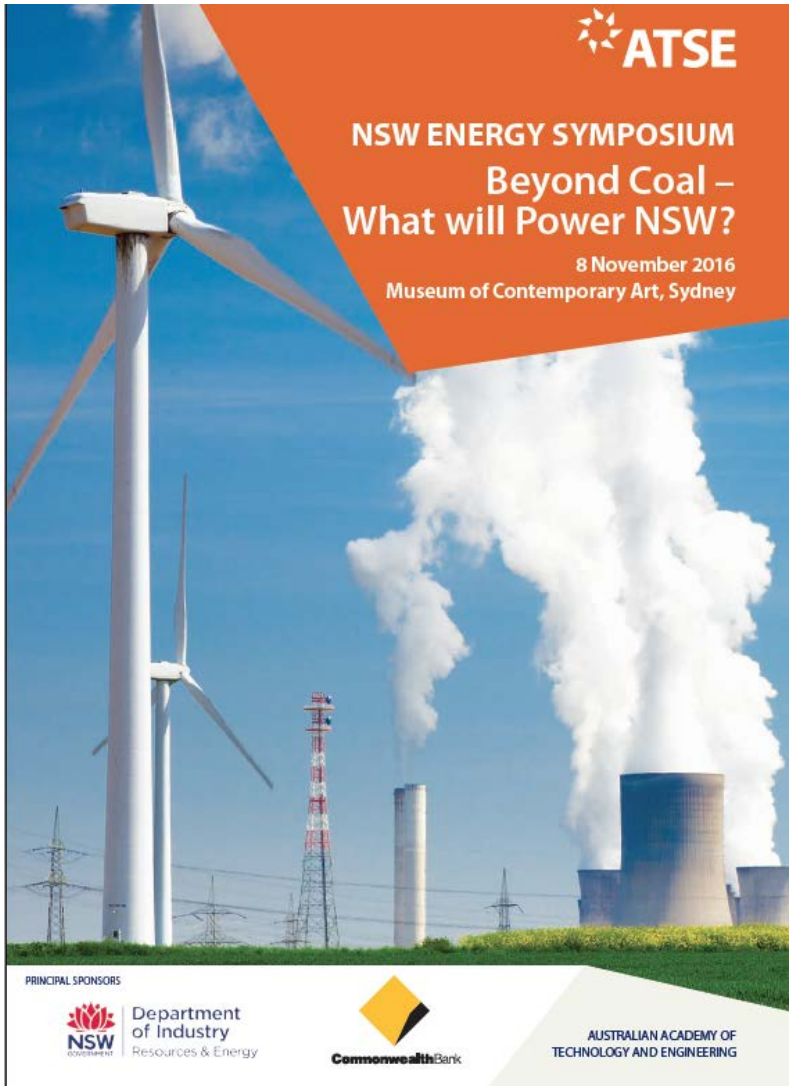
JPMorgan is one of the top 10 backers of coal-fired power plants and its previous limits on coal financing were confined to contentious operations such as mountain top mining, where large parts of a mountain or ridge were removed to extract coal.

The bank will maintain corporate lending relationships with big mining groups that produce a range of com-

Several large banks decided to limit coal-related lending in the lead-up to the COP21 meeting in Paris. PHOTO: AP

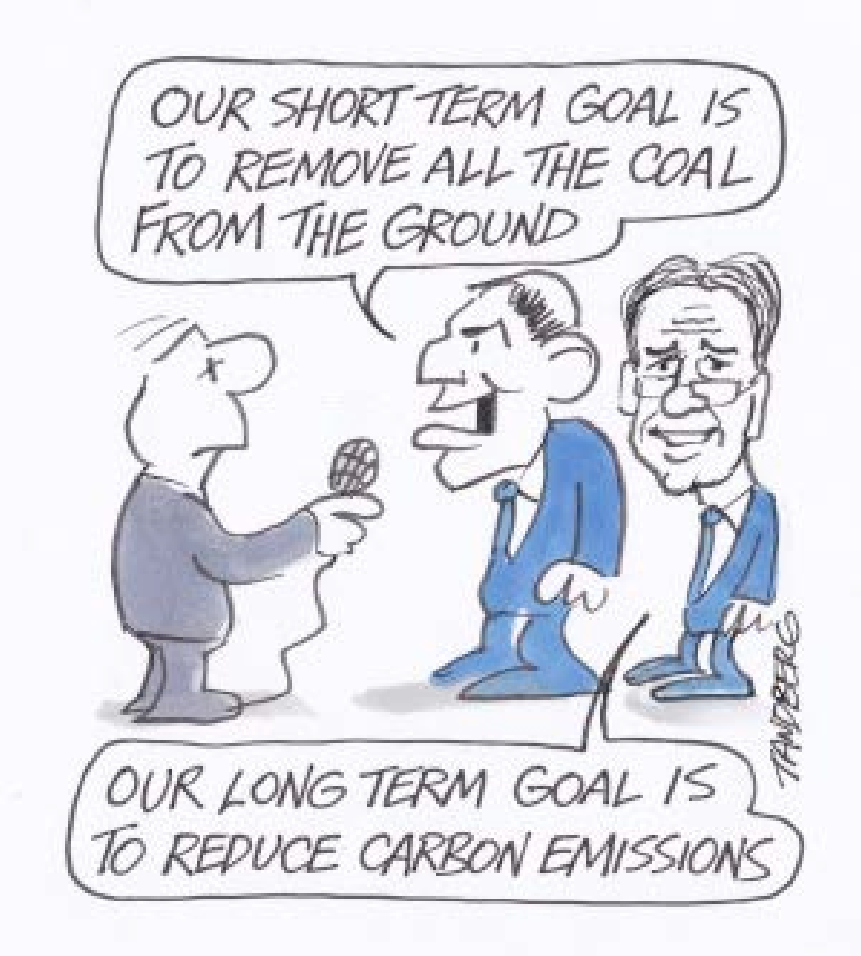
UK – phase out coal by 2023

Canada - phase out coal by 2030



AFR 9 Mar 2016

Politics gets in the way



Republican hopefuls reap $62m in support from donors with fossil fuel ties

Transition to renewables

We Might Have Finally Seen Peak Coal

BY JOE ROMM JAN 14, 2016 9:14 AM

Chinese coal use peaked back in 2013, as Climate Progress first reported in May. Since China was responsible for some 80 percent of the growth in global demand since 2000 — and since the United States and most of the industrialized world have also started cutting coal use — the key remaining question for the dirtiest fossil fuel was, "Will a handful of developing countries, particularly India, see enough growth in coal consumption to overcome that drop?"

Goldman Sachs, among others, says the answer is no. "Peak coal is coming sooner than expected," Goldman told clients in a September research note. Goldman projects global demand for coal used in electricity generation will drop from a peak of 6.15 billion metric tons in 2013 to 5.98 billion in 2019 (the end of its forecast range).

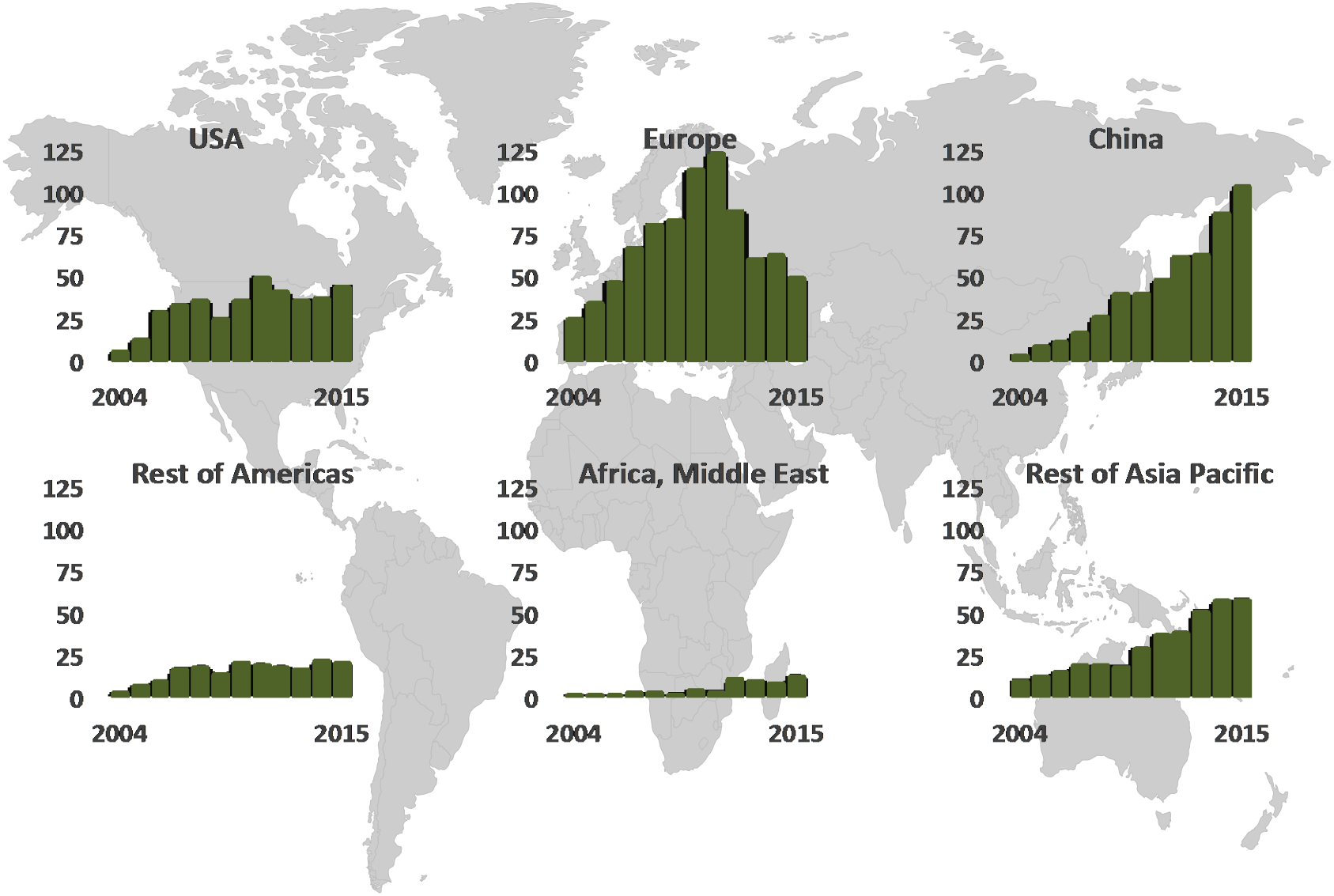
By 2030, Renewables Will Be The World's Primary Power Source

BY JOE ROMM JAN 27, 2016 9:20 AM

In November, the International Energy Agency quietly dropped this bombshell projection: "Driven by continued policy support, renewables account for half of additional global generation, overtaking coal around 2030 to become the largest power source."

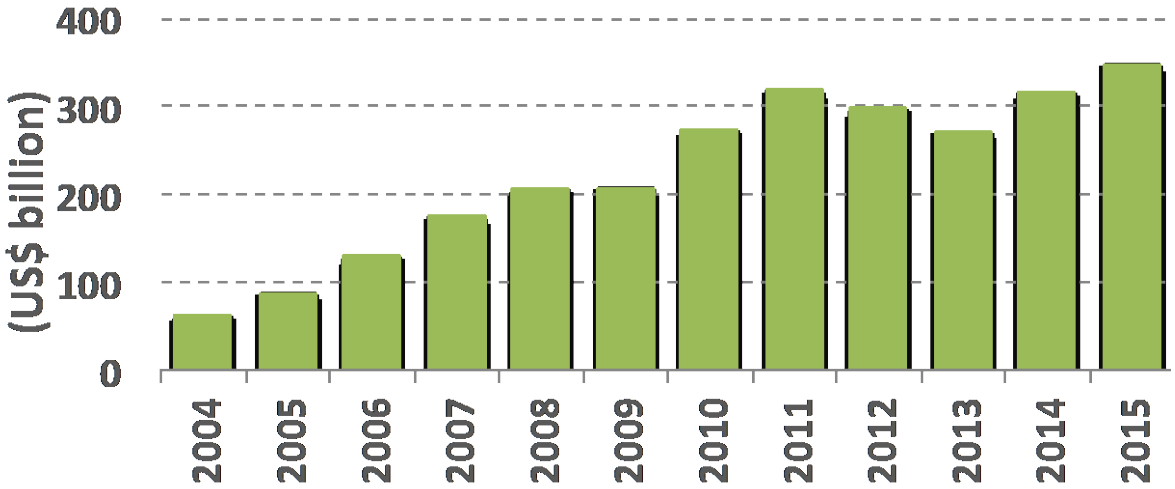
International Energy Agency; Climateprogress

Investment in renewable energy by region (US$ billion)

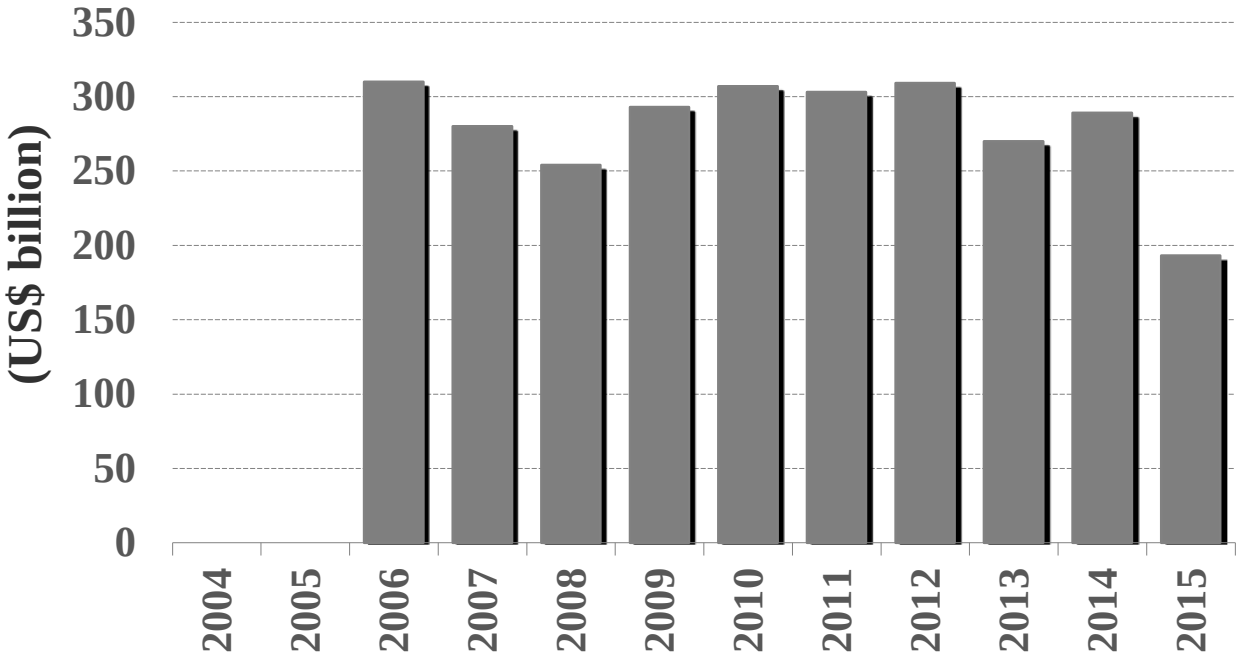


Data from UNEP, Bloomberg New Energy Finance *Peter Littlewood, ATSE 8 Nov 2016*

Global investment in electricity generation

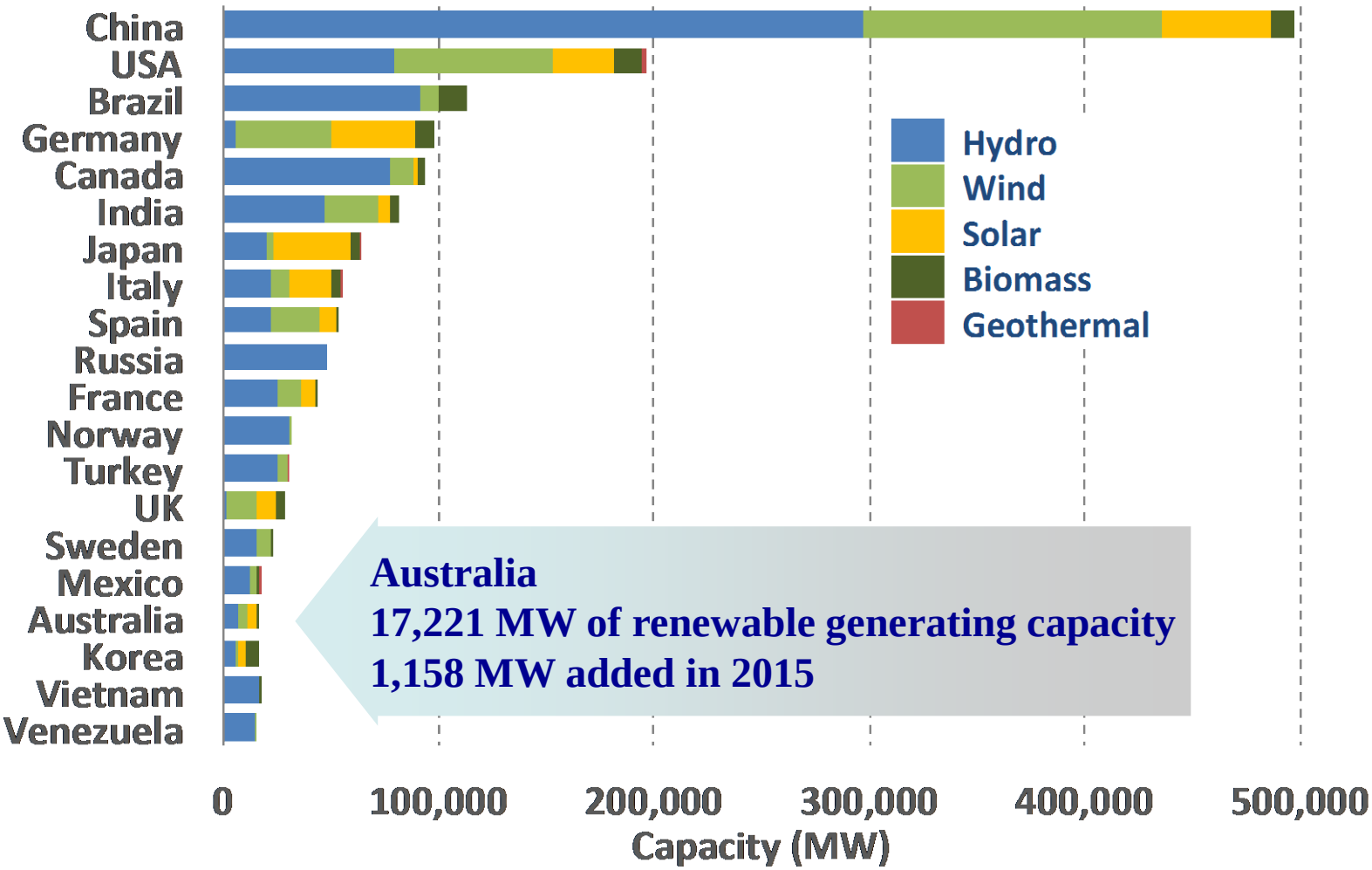


US$ 348 billion invested in clean energy in 2015 (highest ever)



Declining investment in fossil fuel technologies

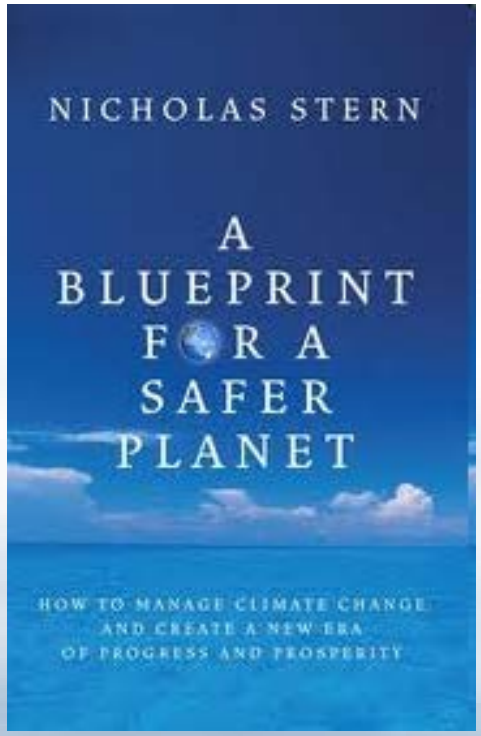
Renewable generation

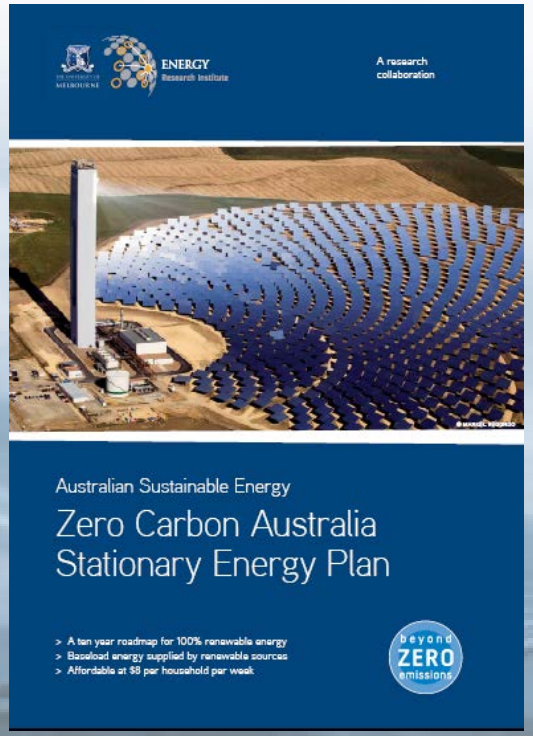


Data from BNEF, *Peter Littlewood, ATSE 8 Nov 2016*

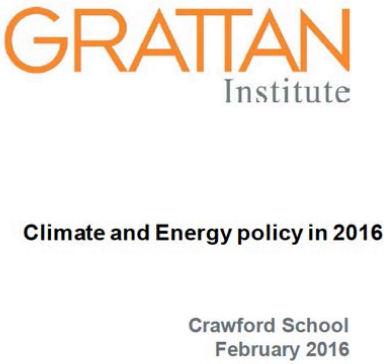
The new industrial revolution

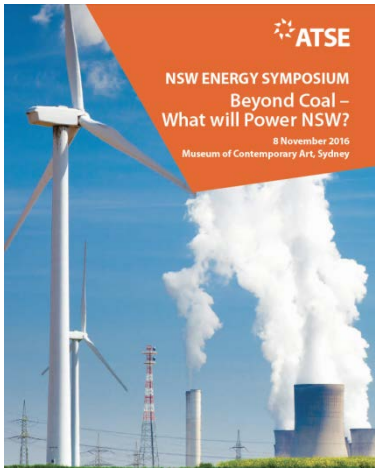
- Renewable energy & clean technologies
- Electric trains and cars
- Biofuels and
- Carbon sequestration
- Energy efficiency





Transformation





ANU, AGL, Climate Institute, Grattan Institute, ATSE

States lead the way on renewables

ACT Government

CANBERRA 100% RENEWABLE

LEADING INNOVATION WITH 100% RENEWABLE ENERGY BY 2020

Queensland Government

A solar future: powering Queensland's renewable energy industries

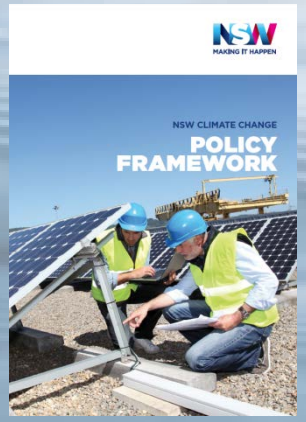
50% RET by 2030

SOUTH AUSTRALIA

50% RET by 2025

VICTORIA State Government

25% RET by 2020



Zero carbon emissions by 2050
(also SA, Vic, ACT)

Australian Government
Clean Energy Regulator

20% by 2020

Where to from here?

"There's a race to the bottom that every advanced economy wants to win: the race to the zero-emissions world.

"To meet the Paris agreement to limit global warming to 1.5 – 2 degrees C will require rapid transformation.

"Change on this scale can only be directed by governments, but private sector investments and visionary leadership is paramount.

"There's no better time than now.

Australia's Chief Scientist, Alan Finkel

Australia has bipartisan political support for its international commitment to reduce emissions by 5–25 percent from 2000 levels by 2020, but very little bipartisan agreement as to how to achieve these reductions. We have no roadmap beyond that.

ATSE 3 Aug 2016; Climate Institute