Institute and Faculty of Actuaries

Climate Repair: What is a realistic ultimate view of climate change?

6 August 2020

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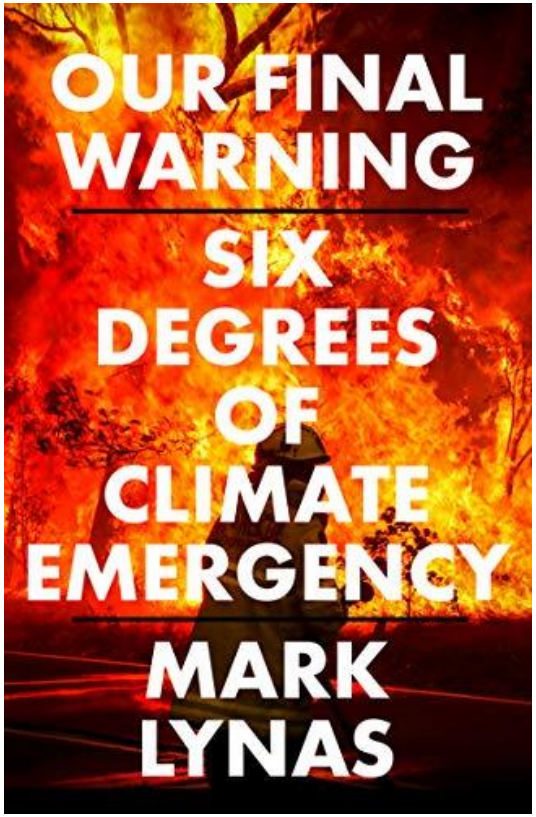
Climate Repair: What is a realistic ultimate view of climate change?

- **Introduction**
- Culture
- Climate change
- Climate Repair

Introduction

- My introduction: The Institute of Actuaries Climate Change working party reported in 2007. It was led by Trevor Maynard.
- “6 Degrees of Warming” by Mark Lynas was published in 2007. It won the Royal Society prize for best science book.
- The second edition, “Our Final Warning” was published in 2020.
- *This talk will focus on logos and ethos over pathos*



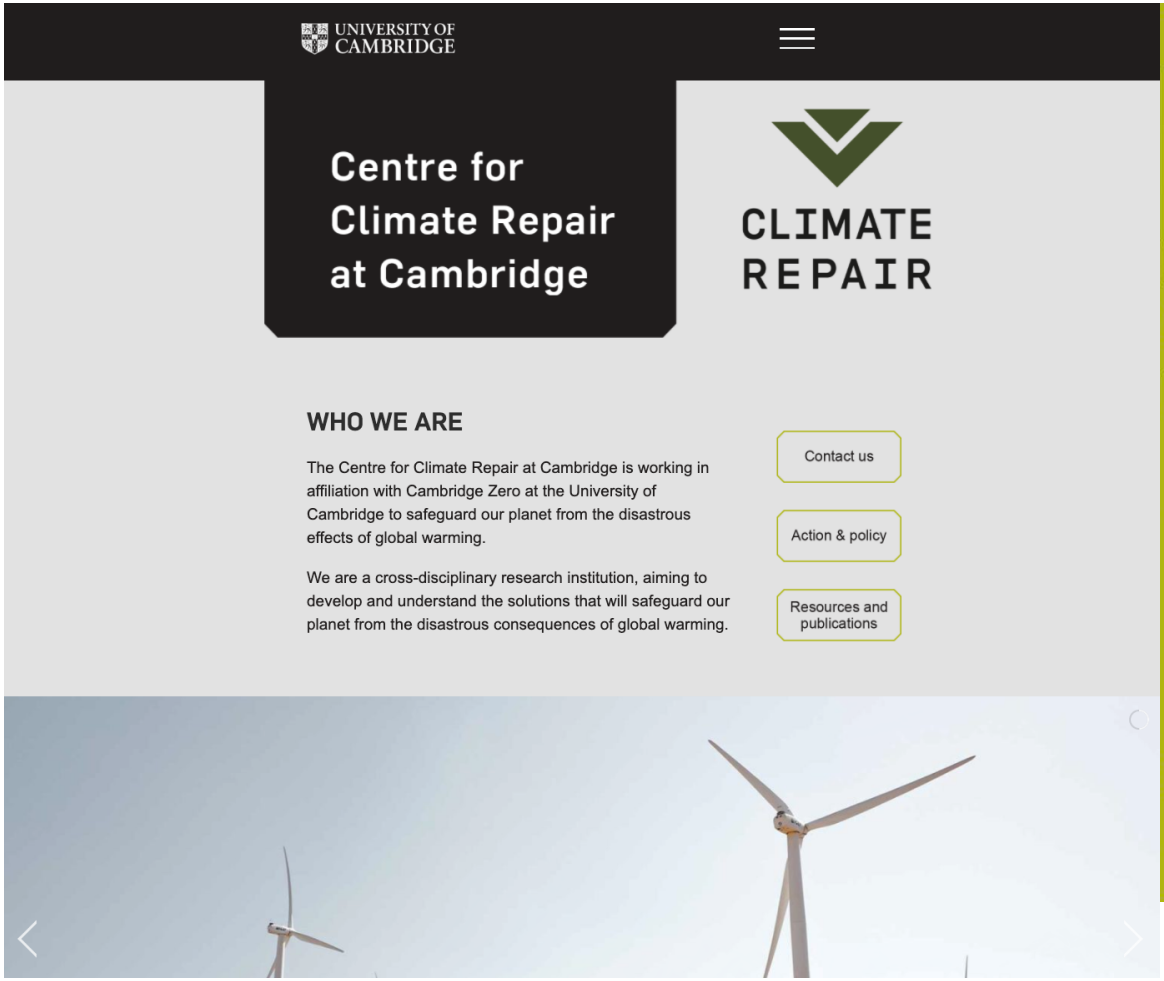
Main message

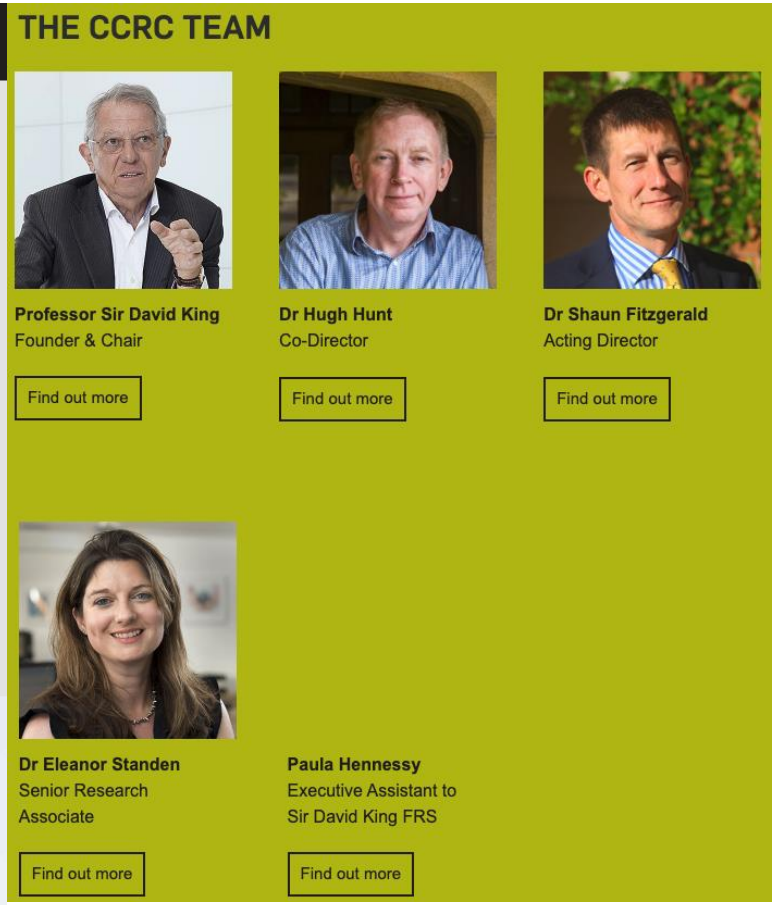
1. Short-term: emissions need to be reduced to zero as fast as possible.
2. Longer-term: it will be necessary to reduce atmospheric CO_2. “**Climate Repair**”

- Goal 1 is widely accepted today.
- **Goal 2 should be more widely known.**

It makes sense for us to adopt goal 2 and help Climate Repair

Centre for Climate Repair at Cambridge





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Culture

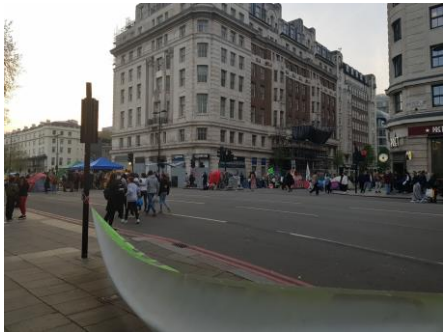
- “Culture is an umbrella term which encompasses the social behavior and norms found in human societies, as well as the knowledge, beliefs, arts, laws, customs, capabilities, and habits of the individuals in these groups.”
- Cultural/political changes are generally unpredictable
- But, culture change is predictable, if science shows risk, but the knowledge takes time to permeate society.
- E.g. pollution, asbestos, smoking

Changing Culture
Smoking (UK as an example)

- 1955 Richard Doll proves that smoking causes lung cancer
- 1962 c.60% of UK population smoke
- 1974 45% of population smoke
- 2007 Smoking indoors banned
- 2015 Proportion of smokers falls to 17%
- 2016 Plain packaging introduced
- 2018 Proportion of smokers falls to 14.4%

Cultural shift and ultimate destination is predictable if you know the science (timing is more uncertain).

Modern shift in attitudes to climate change



- These changes in attitude were predictable decades ago from the science of climate change.

The culture of environmentalism

- “Like most normal people , I simply do not want to see direct human manipulation of the world’s climate and weather systems on a day - to - day basis . This seems to me like the ultimate Faustian bargain – we would gain some version of a future , but at the cost of our souls . The planet we would bring into being would not be the Earth I love and want to protect . I admit I cannot justify this position in scientific , rationalist terms . So **I will instead state it truthfully – I find the prospect of an intentionally geoengineered planet morally and spiritually repellent . Yes , it’s better than a dead planet , but only just .”***
- This attitude is typical of environmentalists. They wish to preserve the pristine Earth as it was before humans.
- This attitude has coloured the response to date; passive and against intervening in Earth systems.
- It’s too late for that. Humanity must act as stewards of the Earth system, managing it. (English vs American countryside)

* Mark Lynas in “Our Final Warning”, chapter 7

The culture of science
"Scientific conservatism"

- For scientists, going beyond the evidence is seen as unprofessional.
- If they don't have firm evidence for something, they leave it out of their model (and put a caveat in their paper).

For scientists, 'conservative' estimate = low

For risk managers, 'conservative' estimate = high

- Neither is right or wrong, they suit the nature of their work.
- But must be aware of scientific conservatism when reading climate science.

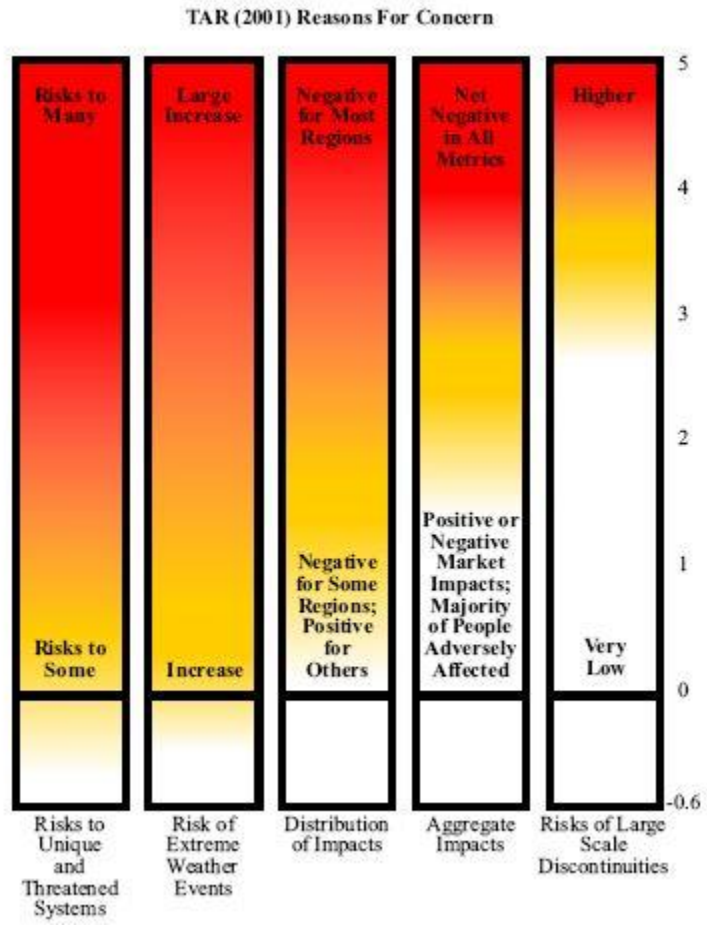
Examples of Scientific Conservatism from "Our Final Warning"

- **Sea level rise, C21st worst-case scenarios.** Each time the issue is revisited the answer gets higher e.g. in 2014 1.8m, 2017 3m. (p208)
- **Ice sheet melting rates** – evidence shows that when glaciers contact warm oceans, rate of ice loss may be up to 100x previous models (p25)
- **Sea ice loss rate** – most models fail to accurately simulate the dramatic sea ice loss already observed.(p68)
- **Changes to global agriculture with warming** – Until fairly recently, consensus was that warming up to 2-3C might be beneficial to agriculture, but we see damage at 1C. (p140)
- **Permafrost thawing rate** – observed thaw depth at some sites today already exceed those projected for 2090 in a three degree warming model. (p161)
- **Carbon loss from permafrost** – based on flawed measurements, standard projections were that 5-15% of carbon would be lost by end C21st. A 2019 paper showed that actually thawed permafrost loses 25% of its carbon in 5 years. (p210)
- **Wet-bulb temperature** – When scientists first proposed the existence of the critical wet-bulb temperature of 35C in 2010 they noted nowhere on Earth was expected to exceed this threshold until the average global temperature rose by 7C. In July 2015 one Iranian town reached just short of it at 34.6C. (p171)
- **6 degree world** – There are almost no papers written on understanding/modelling a future 6C warmer world. (p241) [scientists don't like to talk about extremes]

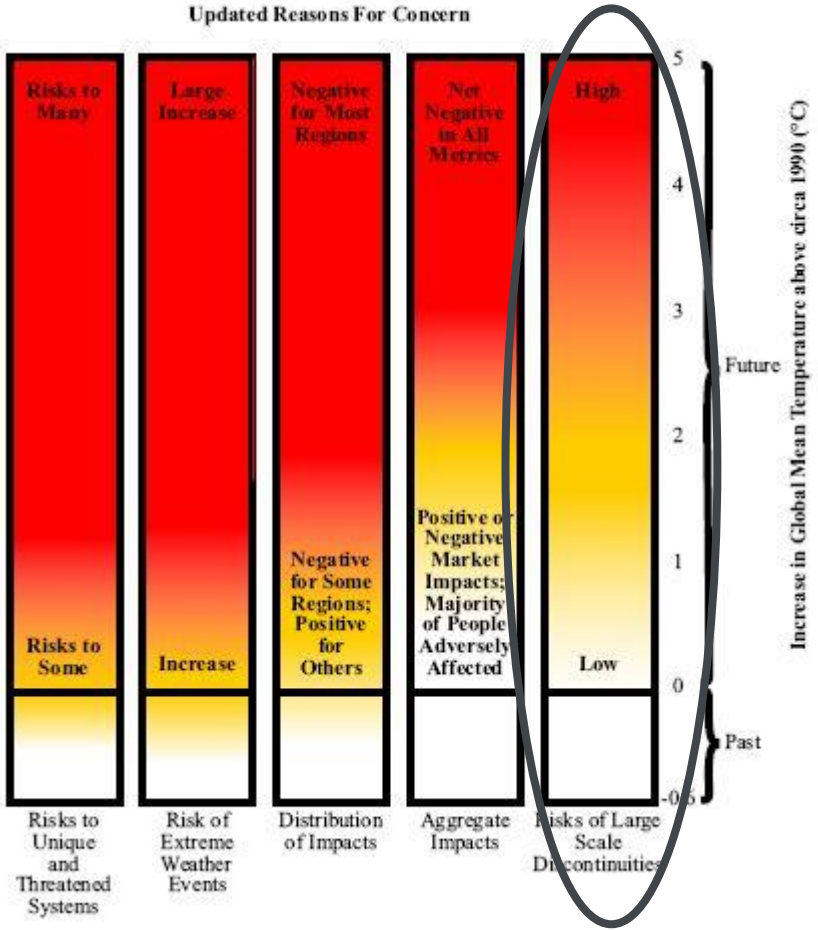
Source: "Our Final Warning" by Mark Lynas, page numbers shown above.

Trend in Climate Science
"Reasons for Concern" diagram

From IPCC Third Assessment (2001)



Updated with latest science (2008)



J.B.Smith et al, PNAS (2008) *www.pnas.orgcgidoi10.1073pnas.0812355106*

What's the Ultimate View of Climate Change?

- It is entirely predictable that the answers from climate science will continue to get worse.
- Very reminiscent of a non-life insurance reserving exercise, with bad news emerging over time.
- As actuaries and risk managers we can see what's going on here and look ahead to the ultimate view.
- Risk management justifies the strongest possible policies to mitigate climate change.

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How does climate change compare with other global risks?

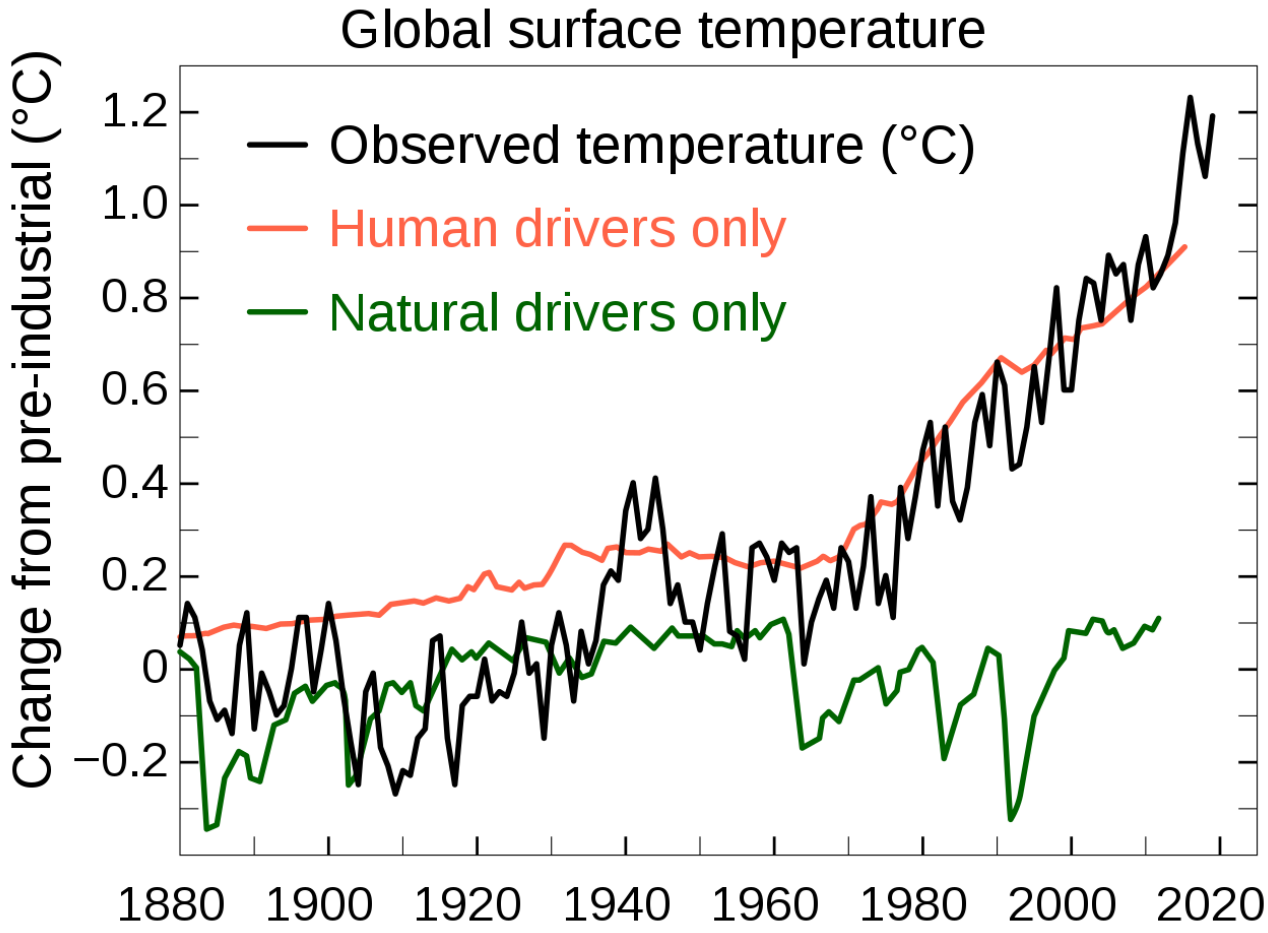
There are only a few risks that may legitimately be called existential. For example:

- Nuclear war
- Large asteroid strike
- Artificial intelligence run amok

Climate change is arguably unique, because:

- the severity of impact is extremely high
- the likelihood is high (“business as usual” is the worst case scenario)

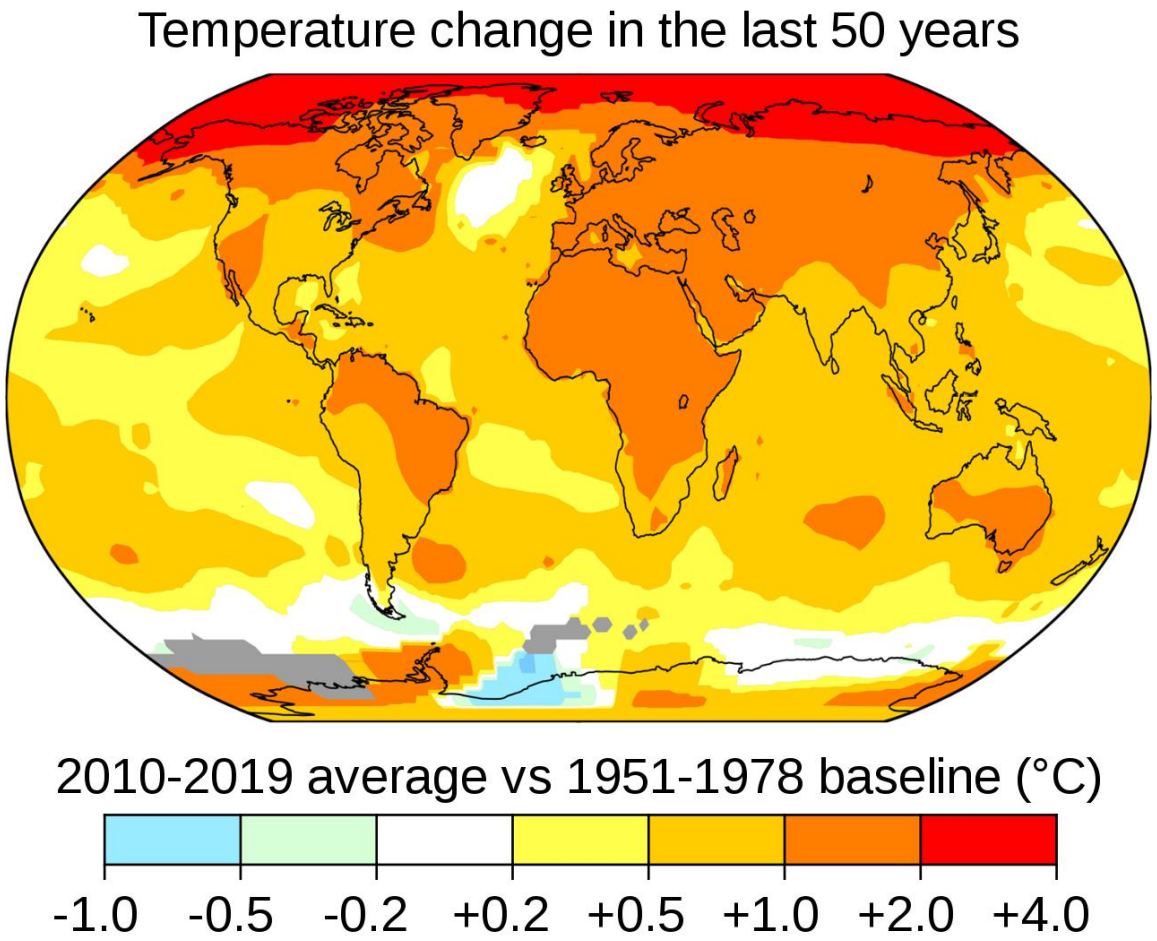
Climate Change – how much has the Earth warmed and why?



- Around 1 degree increase from pre-industrial level.
- Caused by human activity.

Source: NASA

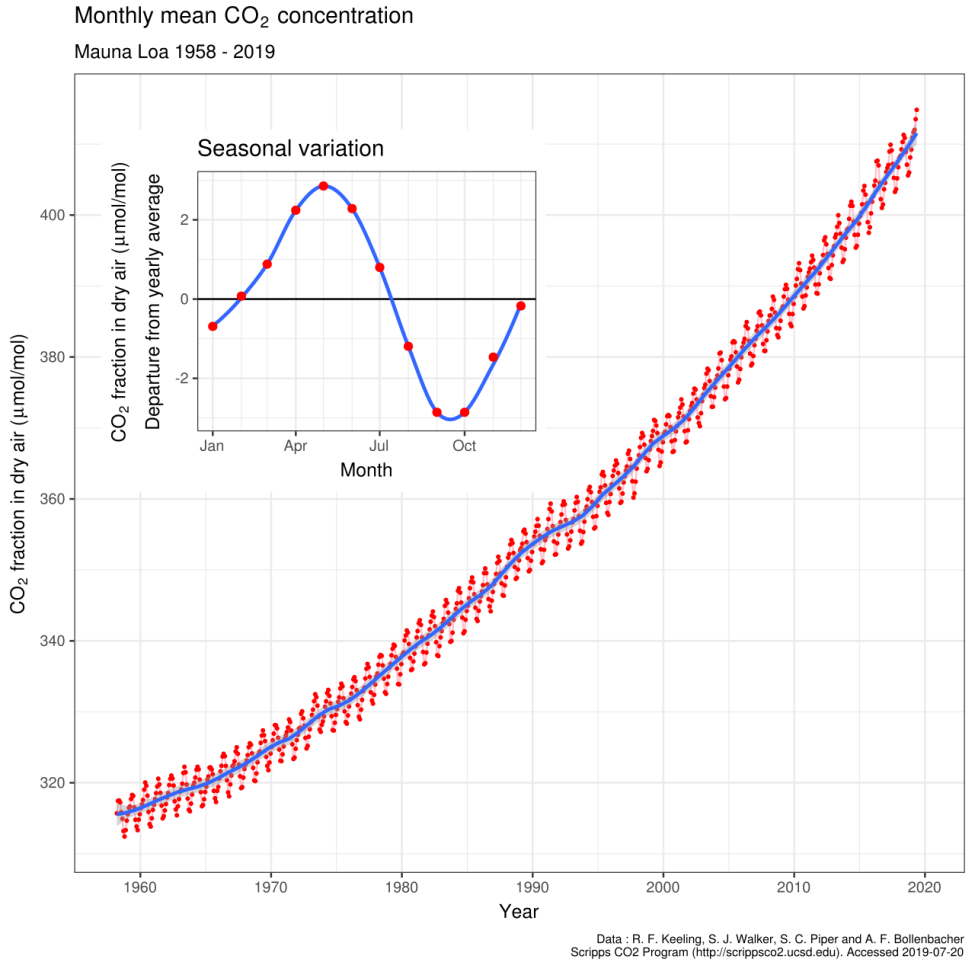
Warming by region



- The arctic has warmed much faster than the global average.

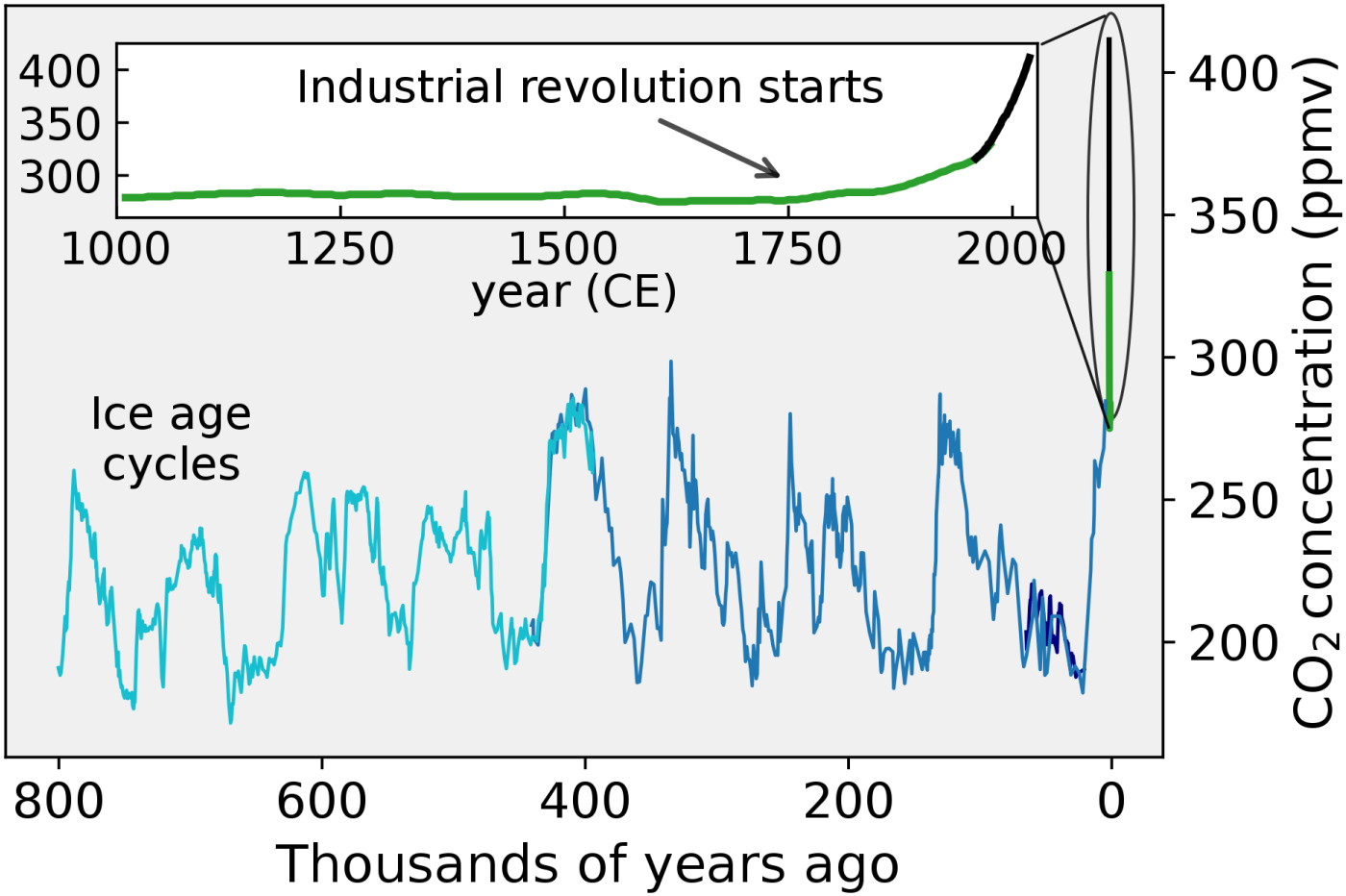
Source: NASA

Current CO_2 concentration



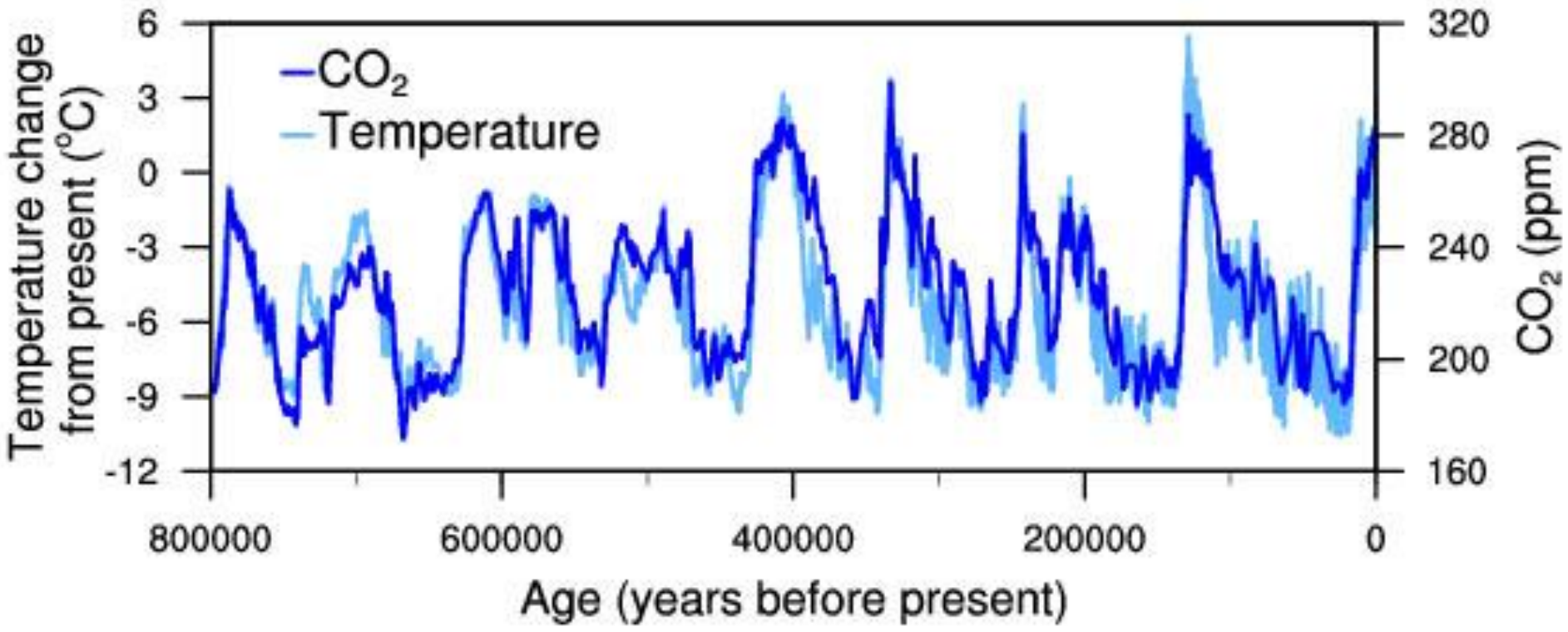
- Pre-industrial revolution 280 parts per million
- In 2020, 410ppm

CO_2 concentration from 800k years ago

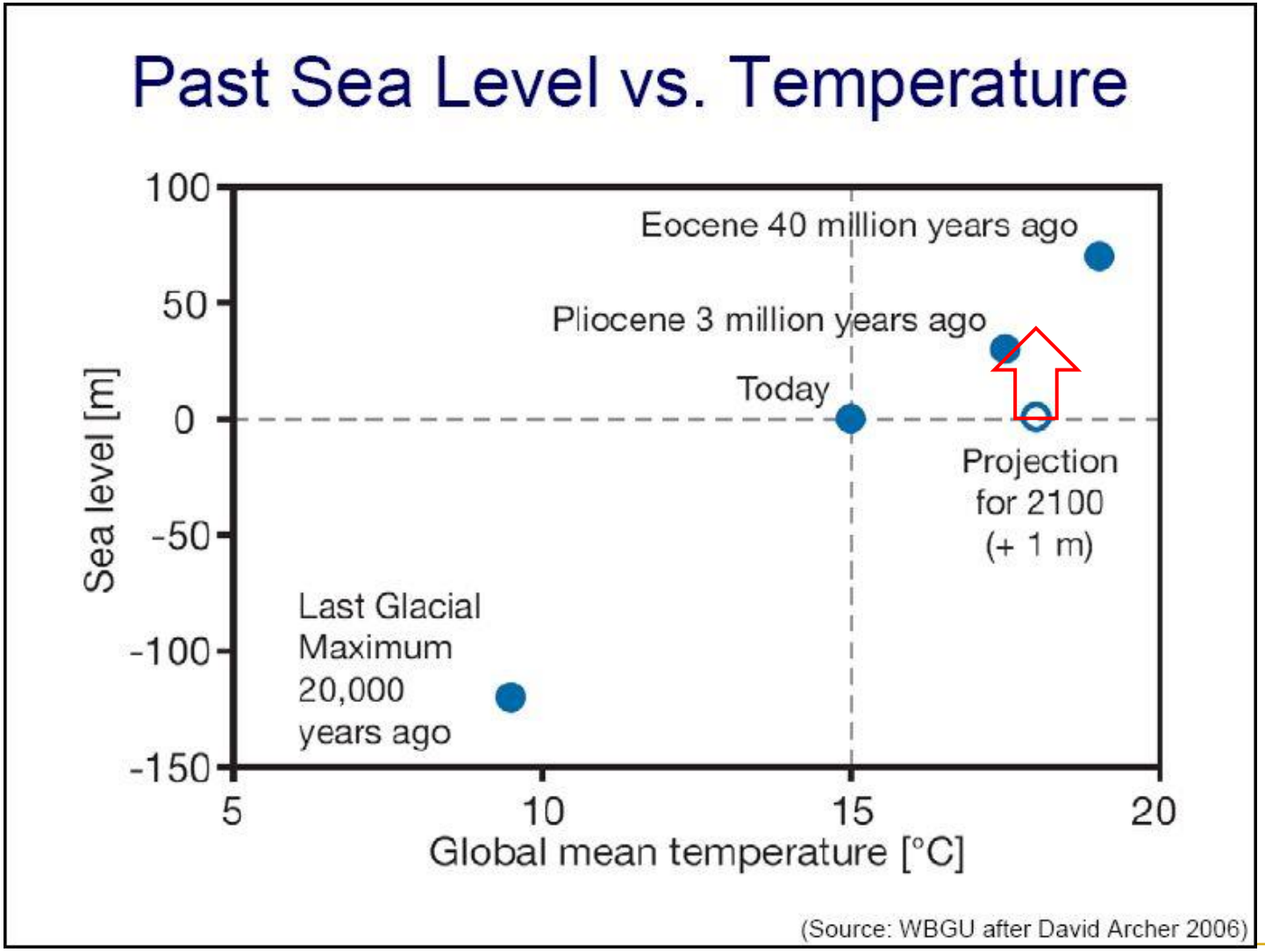


Concentration cycles between 180-280ppm until the industrial revolution.

CO_2 is the Earth's thermostat



Sea level adjusts closely to temperature



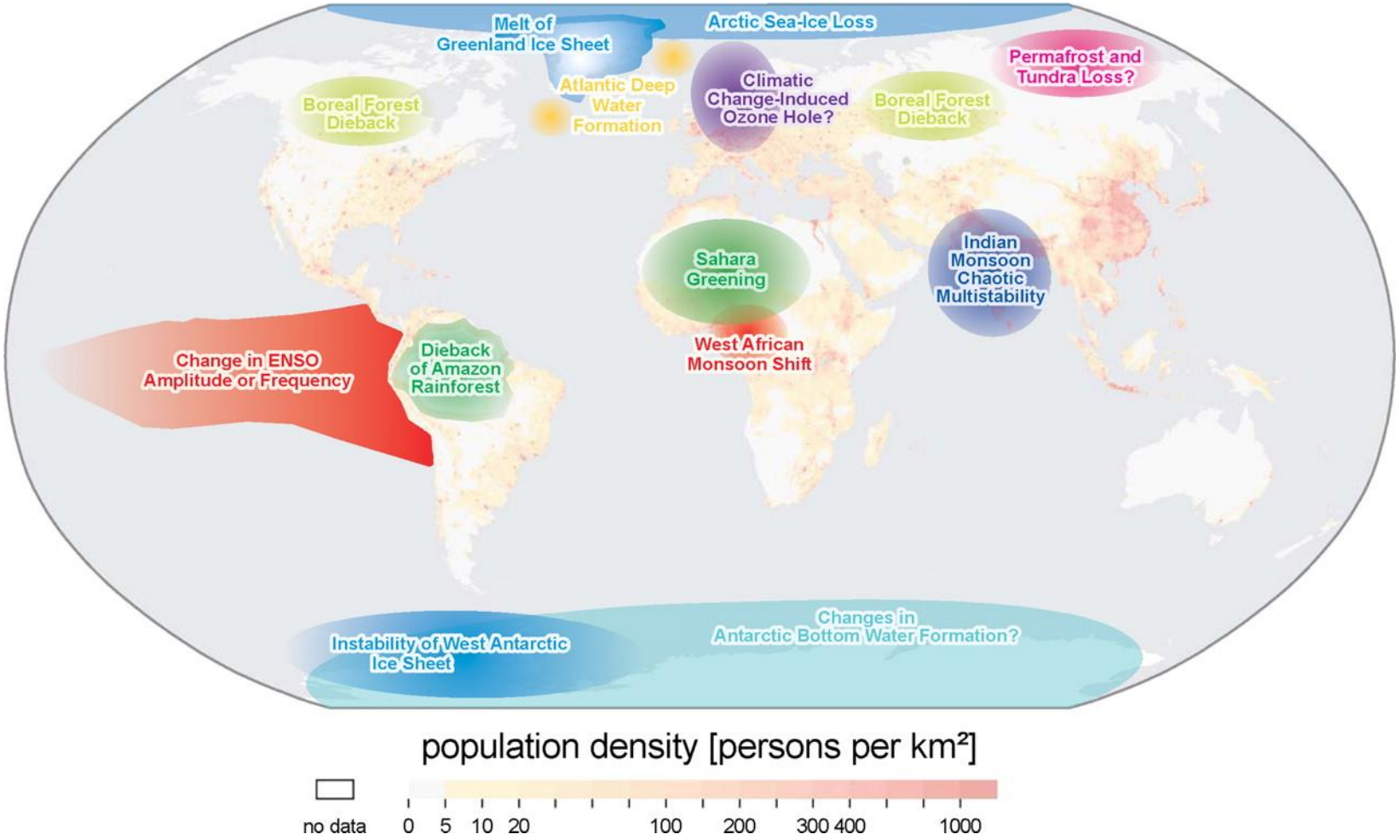
Possible speed of response
In the climate record there has been a period of sea level rise of ~4m per century, for ~500 years.
(not known if this rate could occur with current conditions)

Diagram adapted from Archer & Brovkin, 2008, The millenial lifetime of anthropogenic CO_2

Positive Feedbacks

- Sea Ice (albedo) – Ice reflects 90% of sunlight, open water absorbs 90% of sunlight. Rising temperature melts sea ice which increases temperature further.
- Carbon in permafrost and methane hydrates. Melt permafrost and methane hydrate releases carbon which causes further warming.

Tipping Points in the Earth System

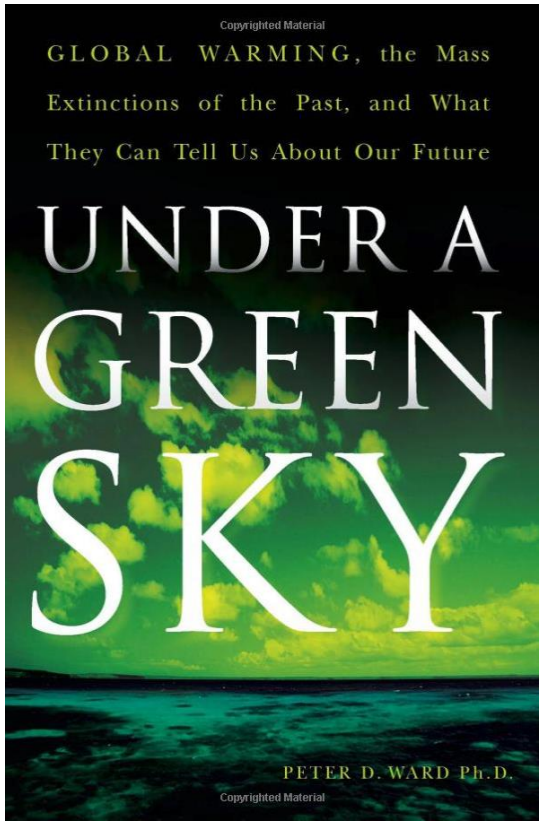


Timothy M. Lenton, Hermann Held, Elmar Kriegler, Jim W. Hall, Wolfgang Lucht, Stefan Rahmstorf, and Hans Joachim Schellnhuber
PNAS February 12, 2008 105 (6) 1786-1793; first published February 7, 2008 https://doi.org/10.1073/pnas.0705414105

Summary points

- Pre-industrial CO_2 was 280ppm. Current level around 410ppm.
- A proportion of emitted CO_2 stays in the atmosphere for thousands of years.
- There is a time delay to warming. If emissions stopped completely tomorrow, warming would continue for 30-50 years.
- Sea-level adjusts closely to temperature. Current CO_2 would generate multi-metre sea level rise.
- Positive feedbacks predominate (except in very long term).
- Studies from Earth's history (paleoclimate) provide strong evidence for the link between CO_2 and temperature.

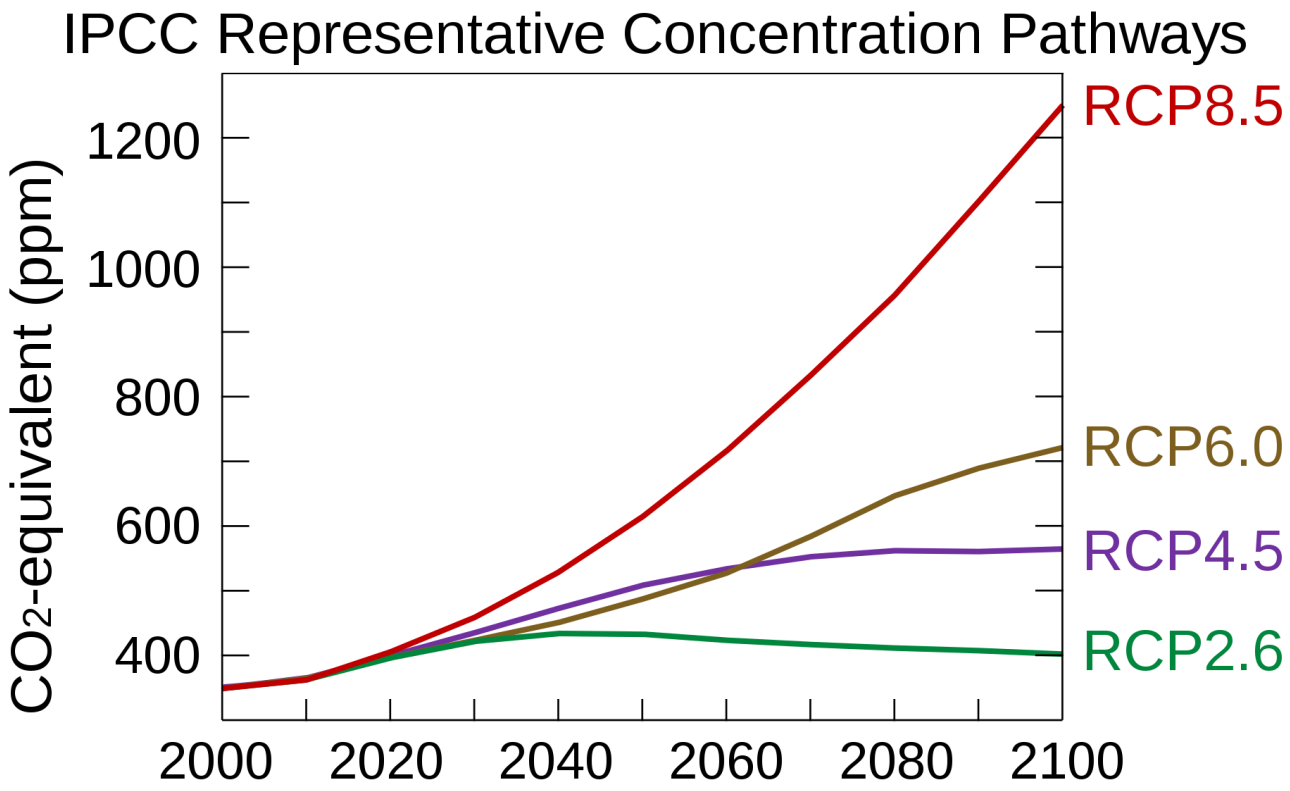
What's the worst case scenario?



- The largest of the Earth's 5 mass extinction events was the end-Permian, 252 million years ago. 90% of life died.
- There was an 8C increase in temperature over around 60k years.
- Seas went stagnant, no oxygen.
- Increase in ultraviolet. Caused by outgassing of hydrogen sulphide which destroys ozone.
- Cause – CO_2 emission from volcanic eruption in the Siberian traps. This was near coal deposits which burned.

"Under a Green Sky" by Peter D. Ward, Harper Collins 2009

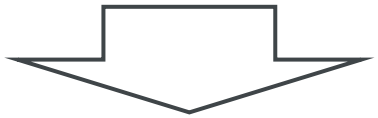
Intergovernmental Panel on Climate Change (IPCC) Scenarios to 2100



- Emissions in recent years have been tracking the RCP8.5 scenario.
- Sometimes the RCP8.5 scenario is called “business as usual” although there is debate about this.

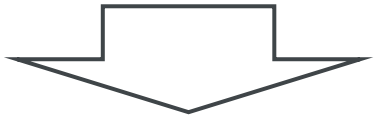
Why hasn’t stronger policy action being taken until now?

1. Emissions produced by our activities cause increase to stock of GHGs



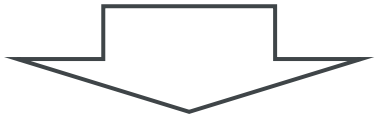
DELAY

2. Energy is trapped in the atmosphere causing warming



DELAY

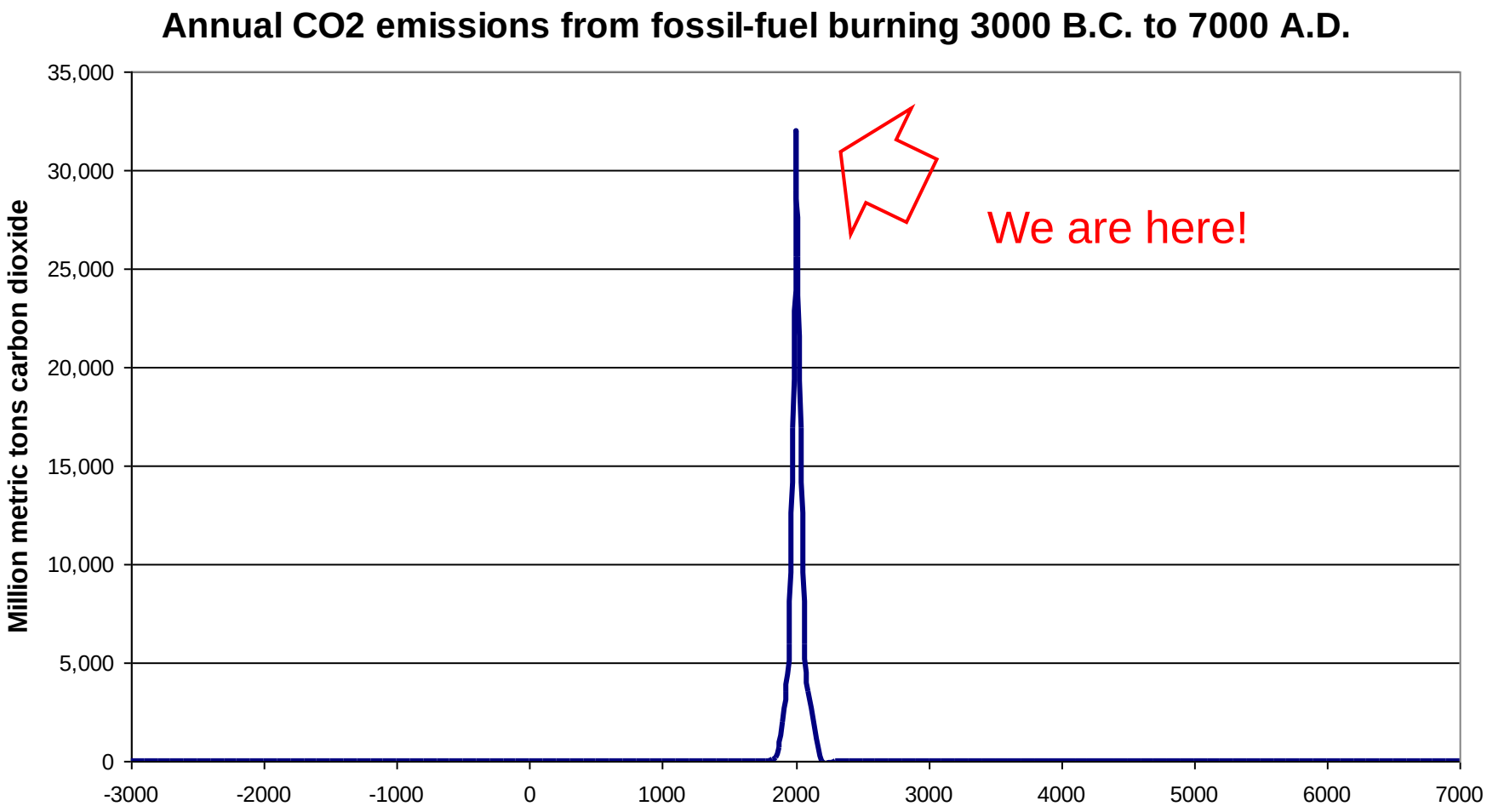
3. Warming causes climate and environmental change



DELAY

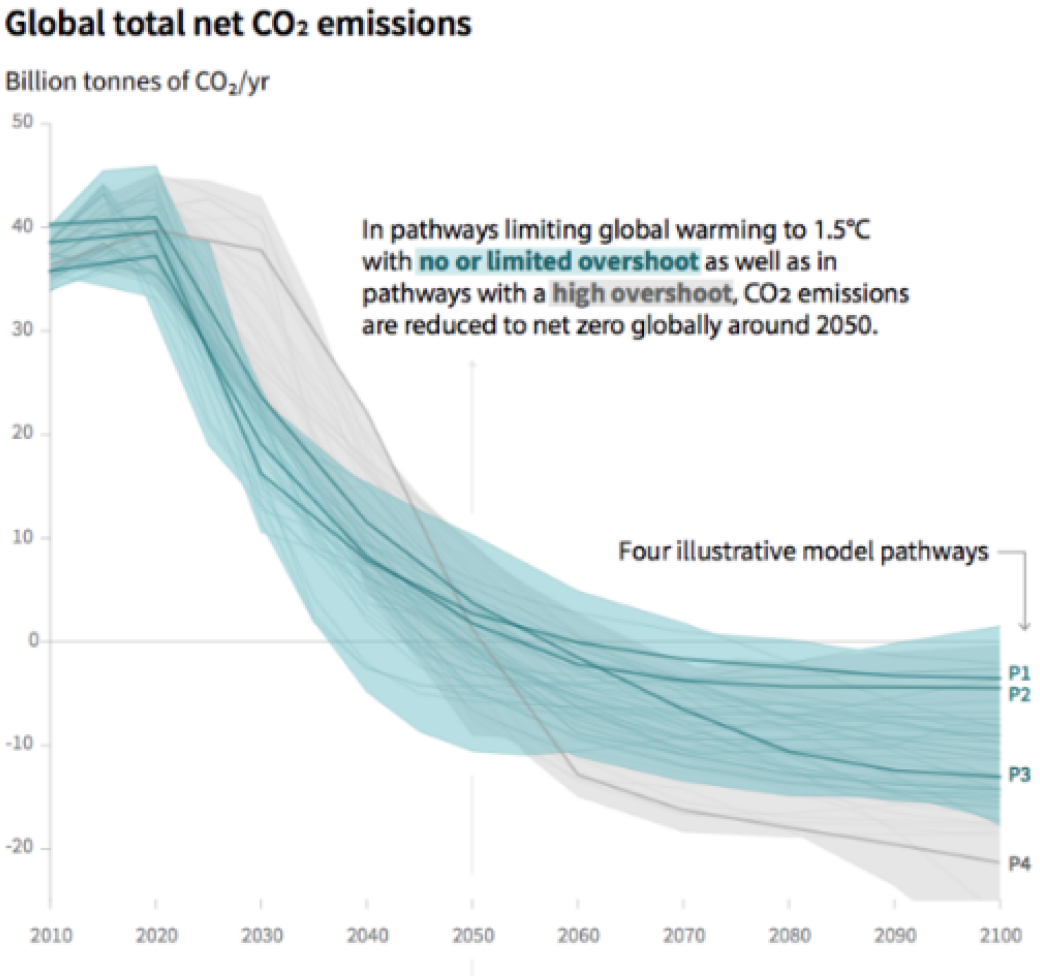
4. The change affects our lives and livelihoods

Annual Carbon dioxide emissions from fossil fuel use from 3000 B.C.



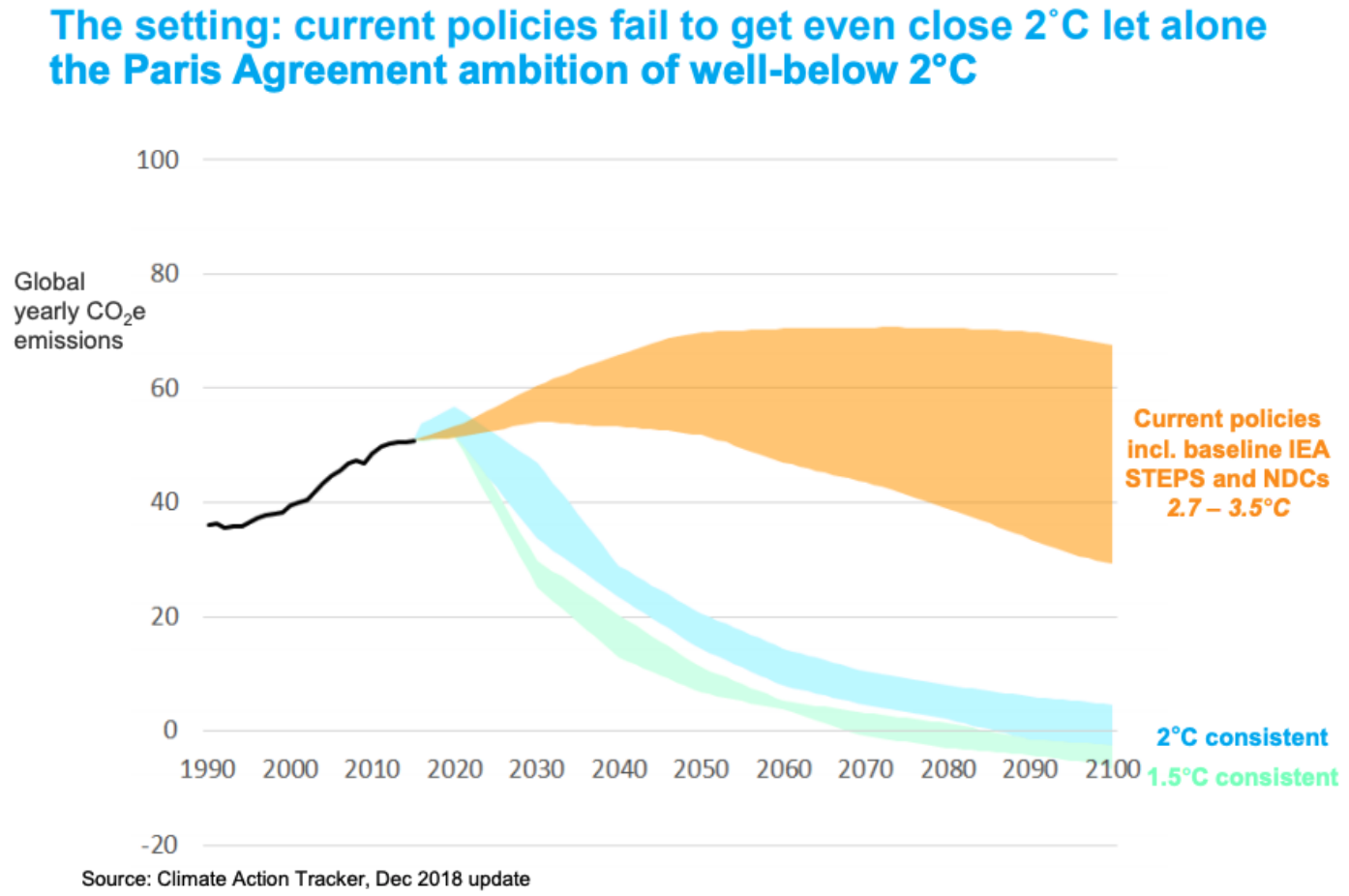
Refer: M.King Hubbert

Emissions pathways to keep under 1.5°C warming



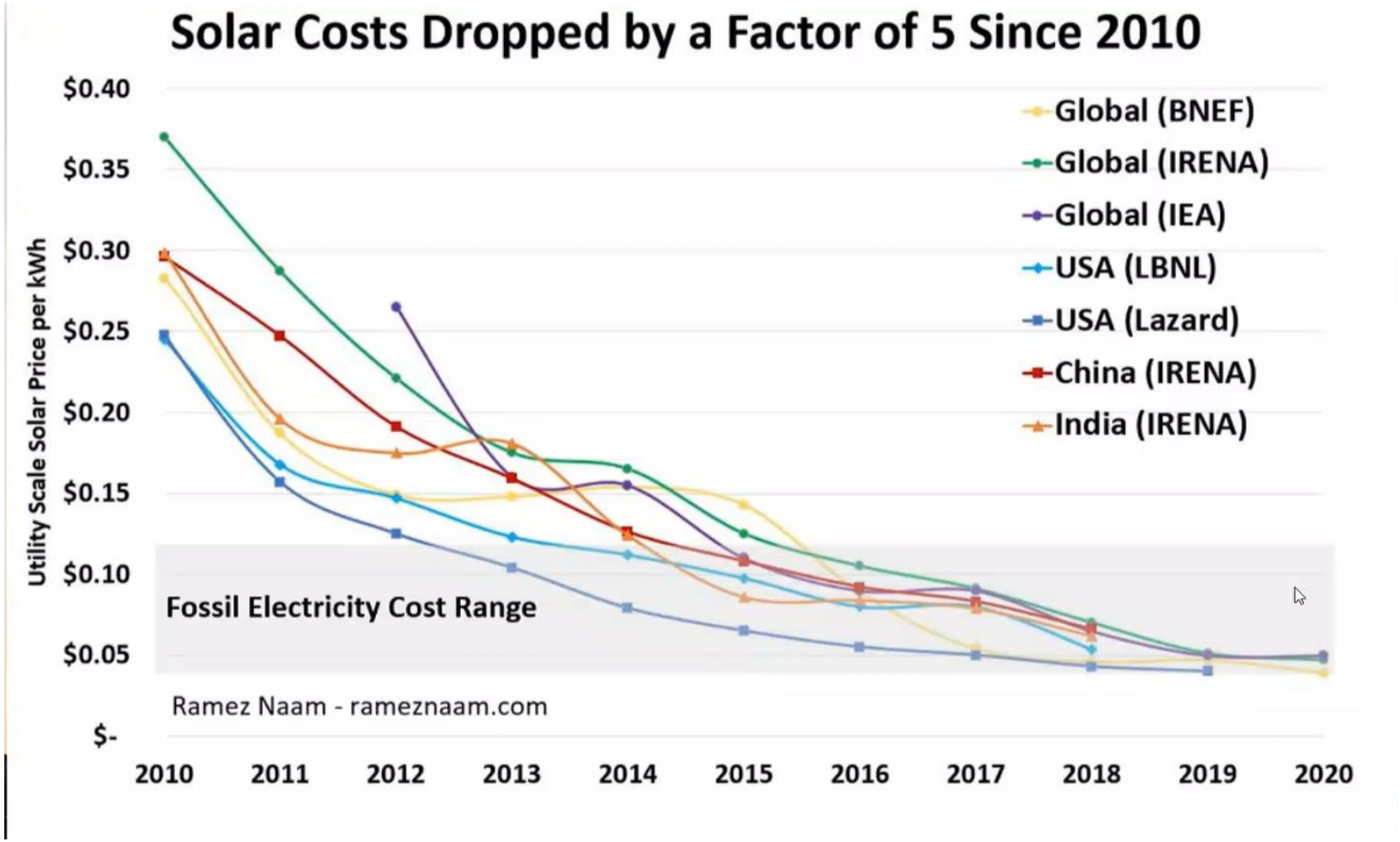
Source: 2018 IPCC Special Report on Global Warming of 1.5°C

The Inevitable Policy Response



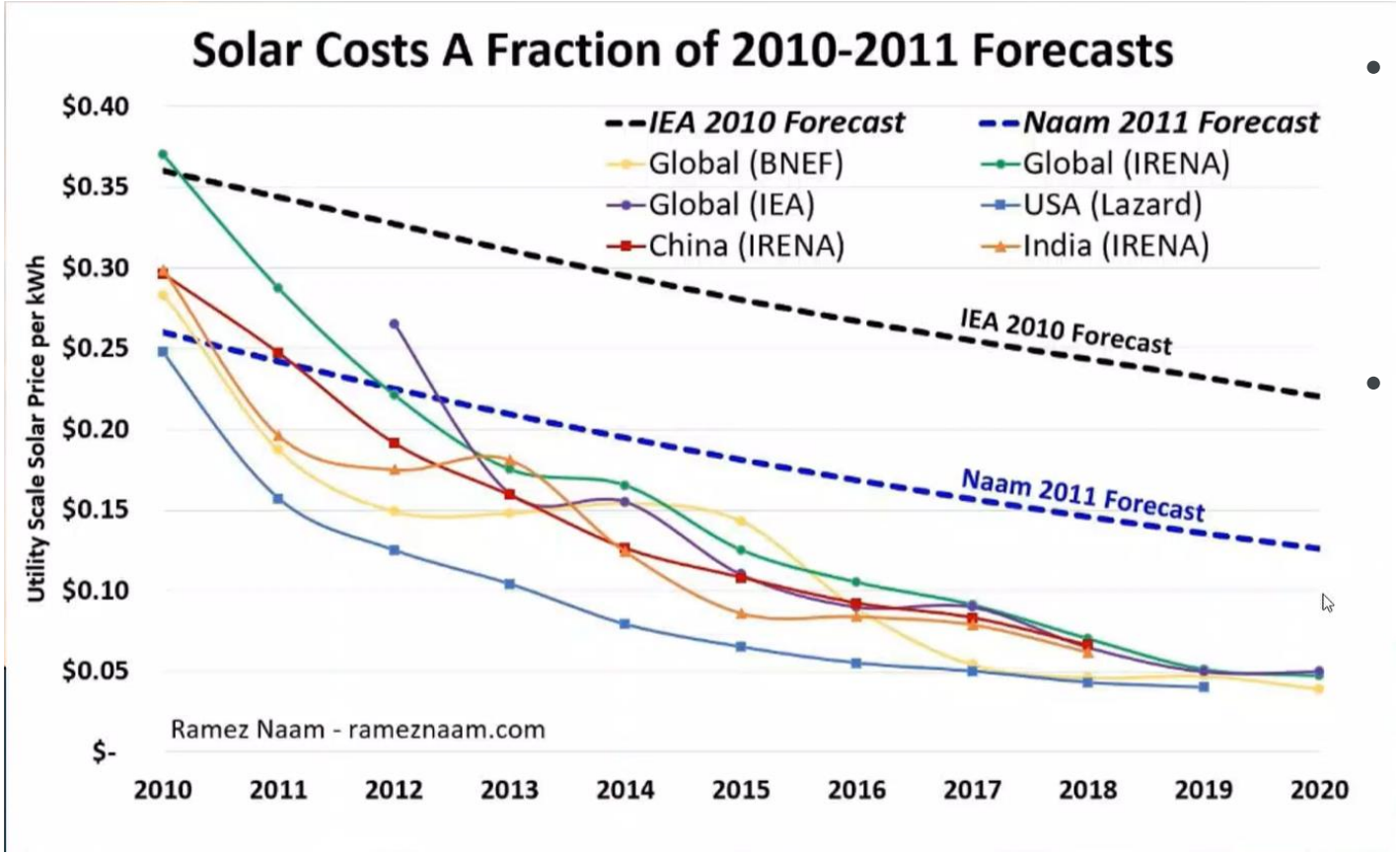
Source: UN Principles of Responsible Investment https://www.unpri.org/inevitable-policy-response/what-is-the-inevitable-policy-response/4787.article

The energy transition e.g. cost of solar power



Source: Clyde & Co. presentation for International Underwriting Association June 2020

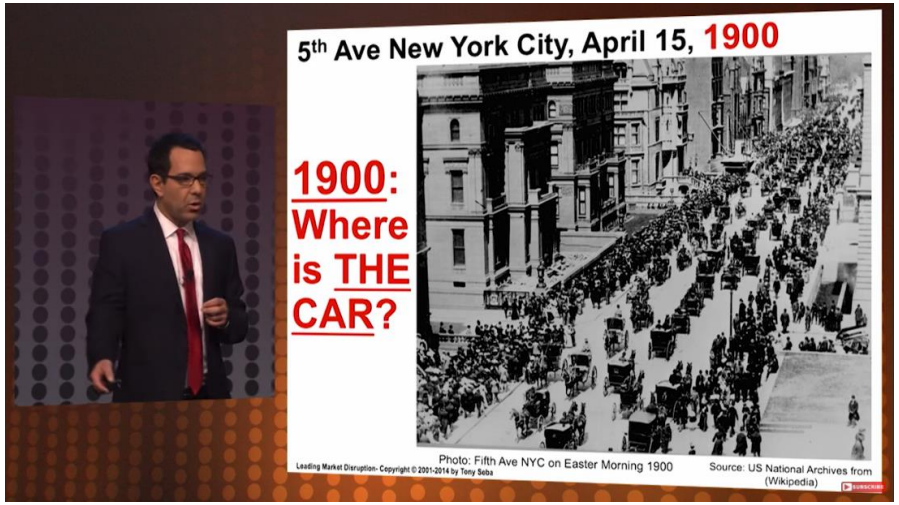
The energy transition: Renewable energy costs are falling much faster than estimated

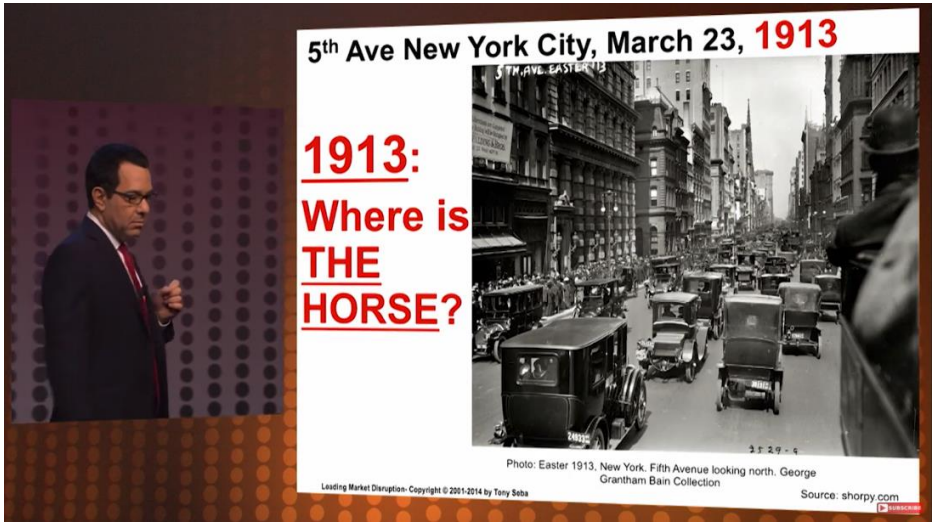


- Same pattern with wind power and battery technology, prices are crashing.
- Fossil fuels are obsolete, they will be eliminated regardless of climate change.

Source: Clyde & Co. presentation for International Underwriting Association June 2020

Transition to clean energy
Technology disruption not energy transition?

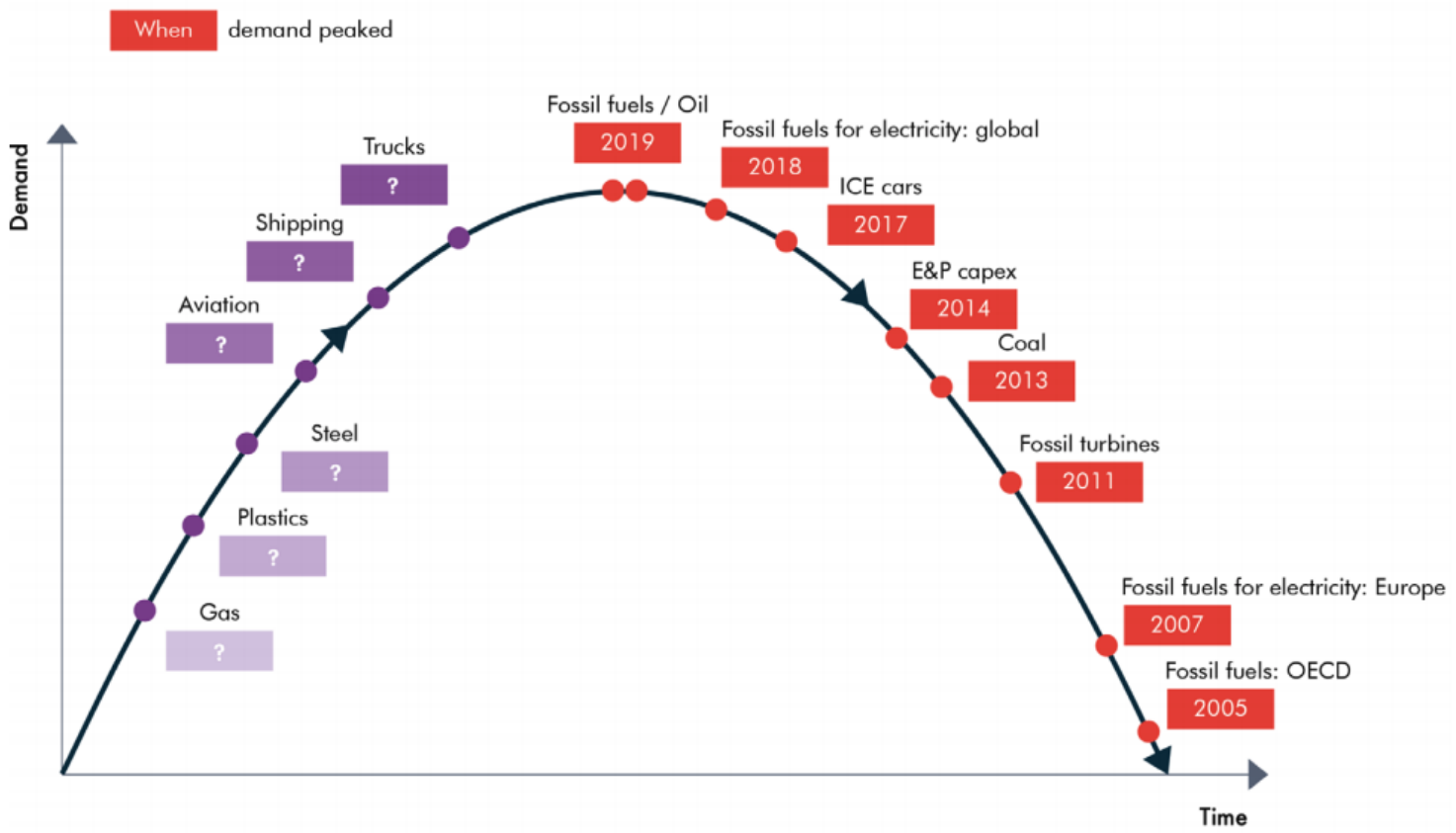




Source: Tony Seba presentation on market disruption

The transition to clean energy may be very rapid, driven by technology and price: Podcast with Doyne Farmer at INET Oxford:
https://www.actuaries.org.uk/finstic-podcasts

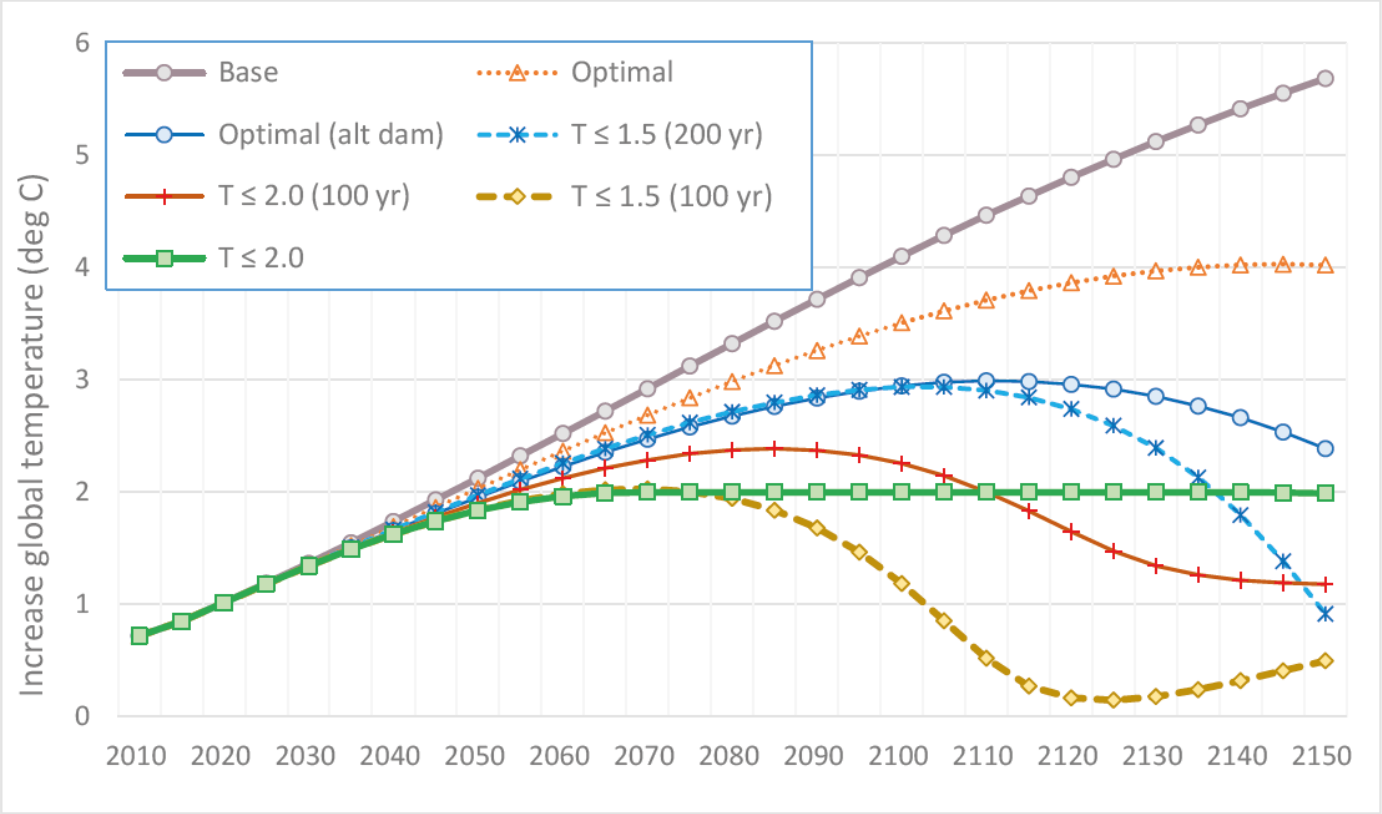
The energy transition
Stranded Carbon Assets



Source: Ember, RMI, BP, GE, BNEF, Carbon Tracker estimates. Note that there is still debate about whether or not peak fossil fuel and oil demand was in 2019

https://carbontracker.org/reports/decline-and-fall/

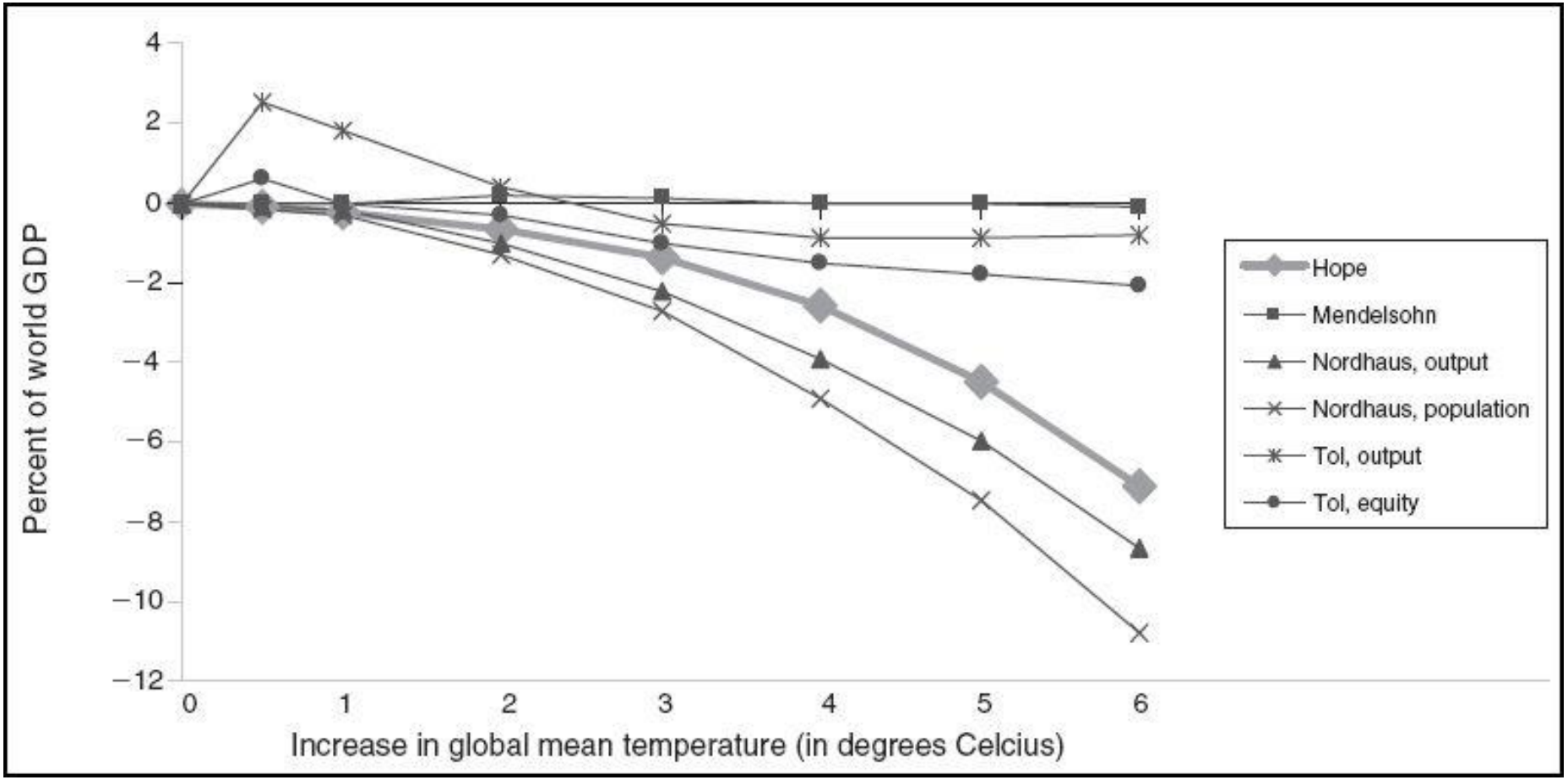
Conventional (neoclassical) economics tells us nothing about climate change



- In 2018 William Nordhaus won the prize for Economics in memorium of Alfred Nobel.
- He won it for his work on climate change economics.
- “Optimal” warming at 3 or 4 degrees?

Source: “Climate Change:The Ultimate Challenge for Economics” William D. Nordhaus, Yale University Nobel Lecture in Economic Sciences, 8th December 2018

Economic model output is absurd



- The chart summarises economic model output from 4 economists.
- Maximum GDP loss at 6ºC warming is less than 12%.
- Therefore these economic models fail a basic sense check.

Stern, Nicholas. 2008. "The Economics of Climate Change." *American Economic Review*, 98 (2): 1-37.DOI: 10.1257/aer.98.2.1

Business and finance are changing rapidly

Many lines of evidence of a shift in finance and business:

e.g. Blackrock CEO Larry Fink's 2020 letter to CEO's

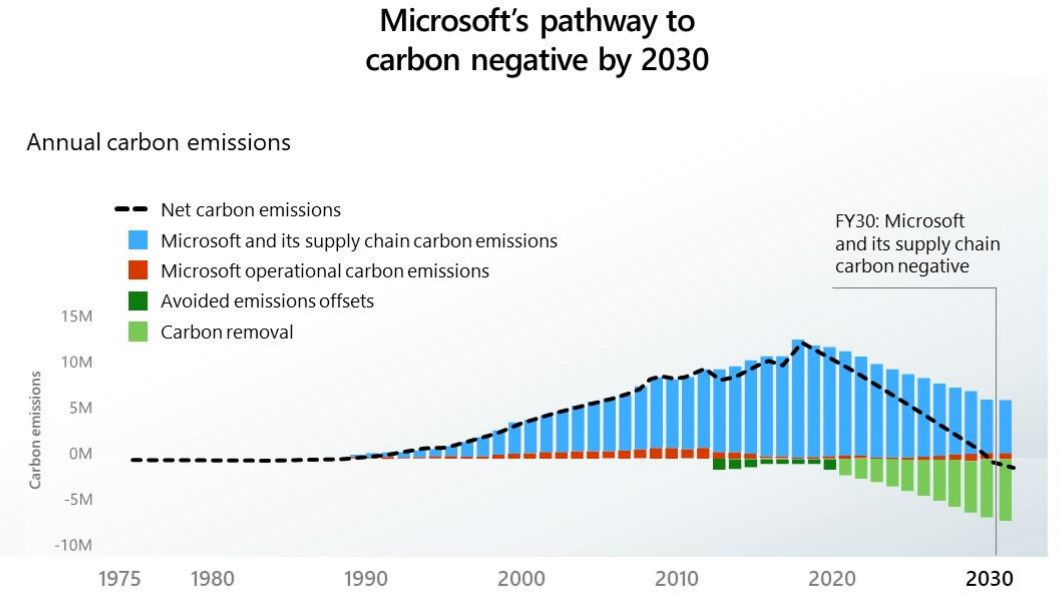
*Markets have been slow to react to climate change. "**But awareness is rapidly changing, and I believe we are on the edge of a fundamental reshaping of finance."***

American Business Roundtable redefines the purpose of a corporation to promote "An economy that serves all americans", 19 August 2019

Financial Times Moral Money newsletter, since mid-2019

Microsoft to remove all historical carbon emissions by 2050

Microsoft President Brad Smith, Chief Financial Officer Amy Hood and CEO Satya Nadella preparing to announce Microsoft's plan to be carbon negative by 2030. (Jan. 15, 2020/Photo by Brian Smale)



Conclusion

- Fossil fuels will be eliminated faster than most people realise.
- Massive shifts in investment are coming. Finance is transitioning rapidly but it has a long way to go.
- **But, getting to net-zero emissions is the easy part.** If emissions were cut to zero tomorrow, the outcome would still be unacceptable from sea level rise alone if nothing else was done.
- Further action is needed, hence Climate Repair

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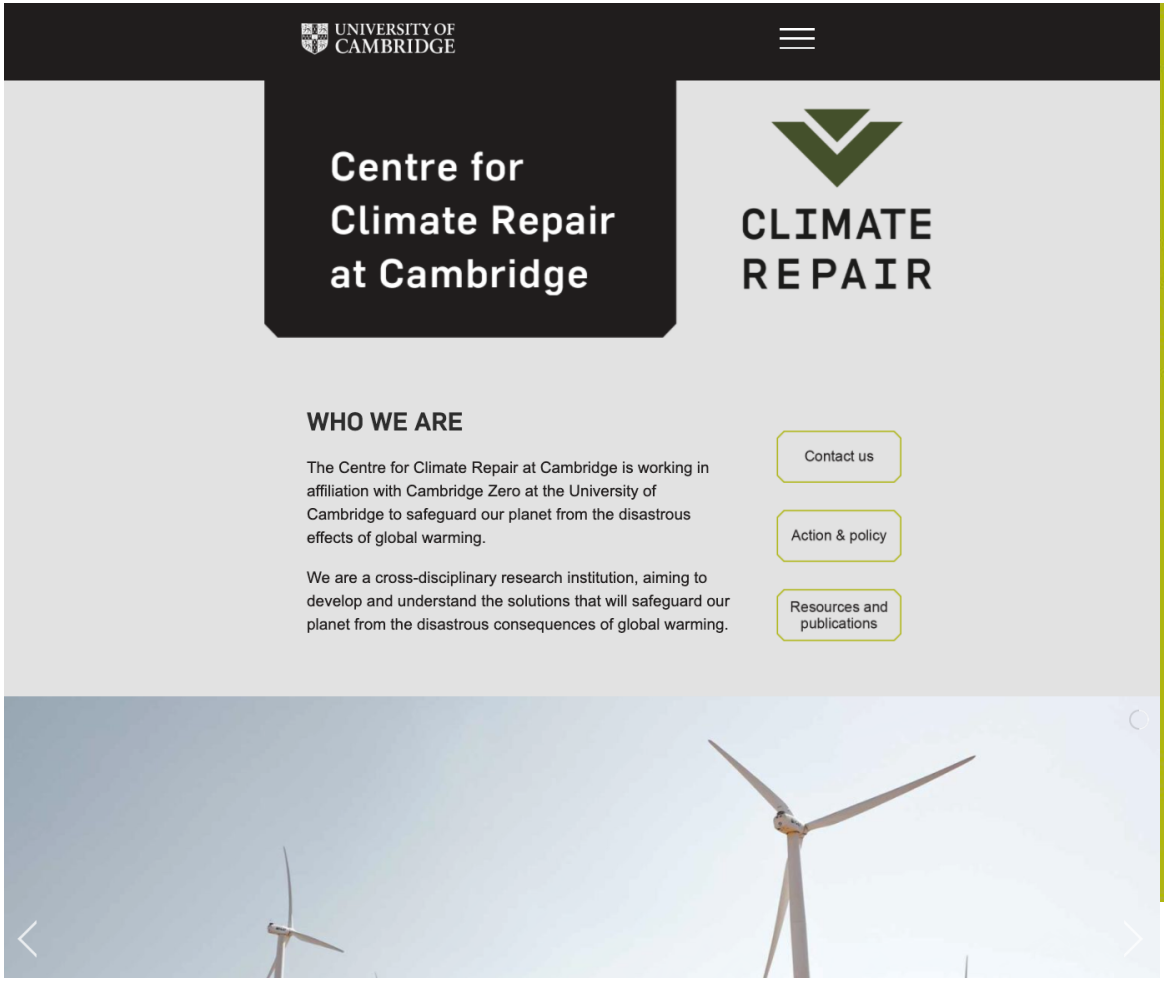
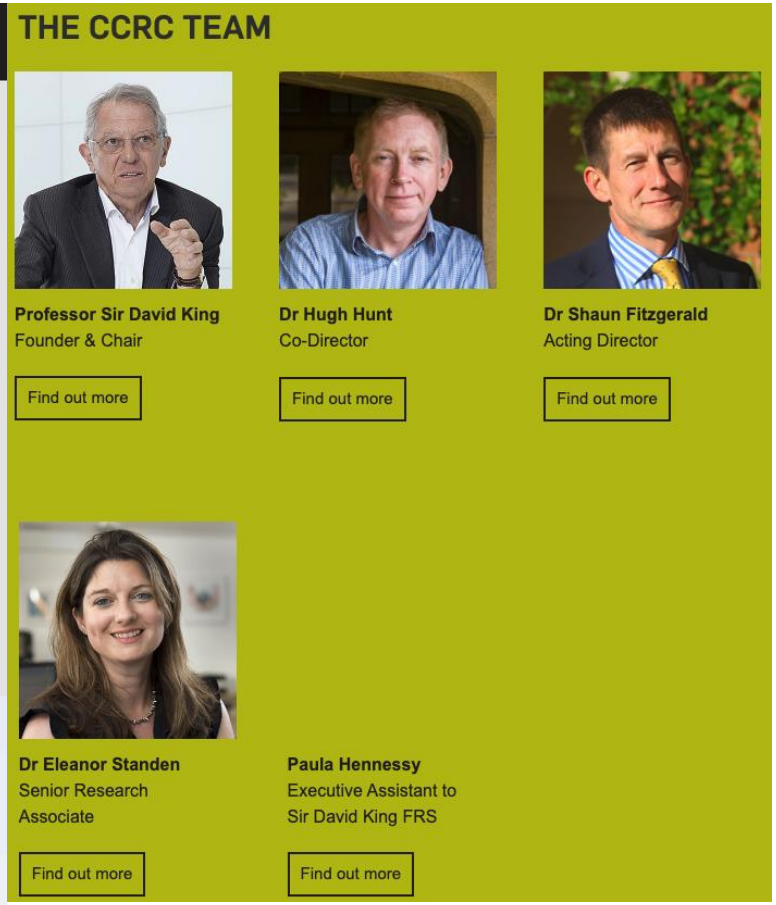
Centre for Climate Repair at Cambridge





Centre for Climate Repair
Briefing Document 1 June 2020

- Today, global average temperatures are at 1.1 °C above the pre-industrial era, new threats to human well-being are already emerging.
- These threats are set to worsen, since **even if global emissions of greenhouse gases (GHGs) could be reduced to zero immediately, trends in average global temperatures would continue to rise for the next 30 to 50 years**, resulting in extreme weather events of increasing severity, rising sea levels and changing rainfall patterns.
- **The rise in Arctic Circle temperatures are of particular concern.** This region is warming 2.5 times faster than the average for the rest of the planet. The Arctic sea ice now covers much less of the ocean in the summer months than it did at the end of the last century, with a 40% reduction in sea ice since 1979. This creates a positive feedback loop: white ice, which reflects solar radiation, is being replaced by blue ocean, which absorbs the radiation, further warming the oceans and accelerating the melting of the Greenland ice sheet. These positive feedbacks increase the likelihood of significant sea level rises, and it now appears likely that sea level could rise by more than 2 metres this century, sinking many coastal cities and displacing hundreds of millions of people. And if the Greenland ice sheet, which is contiguous with the Arctic Sea, melts entirely, sea levels will rise by 7 metres.

Centre for Climate Repair
Briefing Document 1 June 2020

CCRC calls for:

- **ONE** A deep and rapid reduction in GHG emissions and a halt to deforestation.
- **TWO** Develop techniques to reduce atmospheric GHG levels to below 350 parts per million (ppm), from above 500 ppm today (todays levels of GHGs include 412 ppm of CO2 + other GHGs, primarily methane).
- **THREE** Examine which techniques could be deployed to repair damaged climate systems (such as refreezing the Earth's poles).

“The CCRC will hit the ground running by working closely with the following Cambridge centres”

- The Winton Centre for Risk and Evidence Communication
- The Centre for Risk Studies Cambridge
- The Centre for the Study of Existential Risk

Plus 5 other Cambridge University centres.

What can the IFoA do?

- Collaborate with the Centre for Climate Repair at Cambridge and publicize their work.
- Communicate the true ultimate view of climate change to the financial sector and beyond. The need for reduction of atmospheric CO_2 to <350ppm.
- Evaluate and communicate the economic implications.

Institute and Faculty of Actuaries

Questions or comments?

The views expressed in this presentation are those of the presenter.