

Climate Change

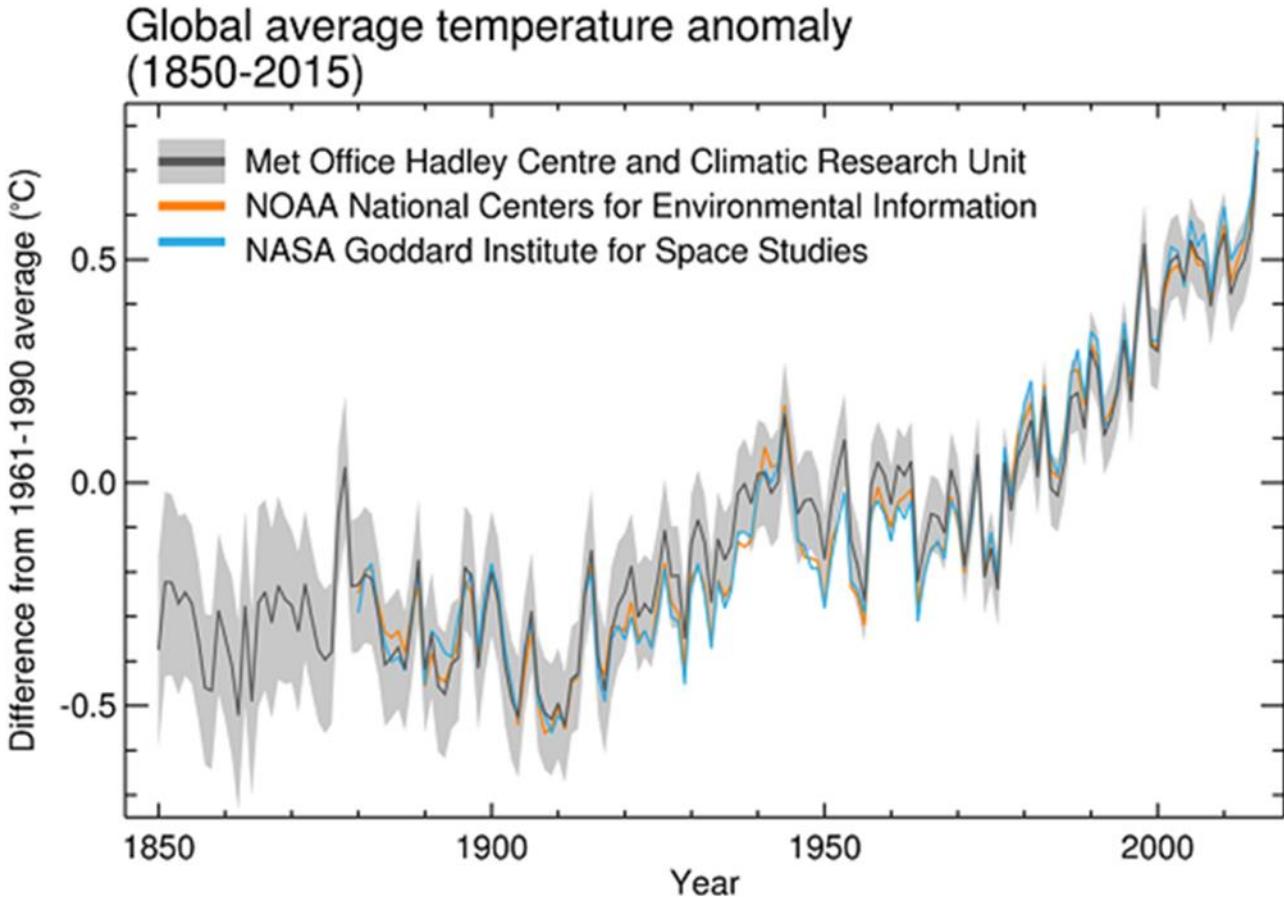
Joanna D. Haigh

Imperial College London

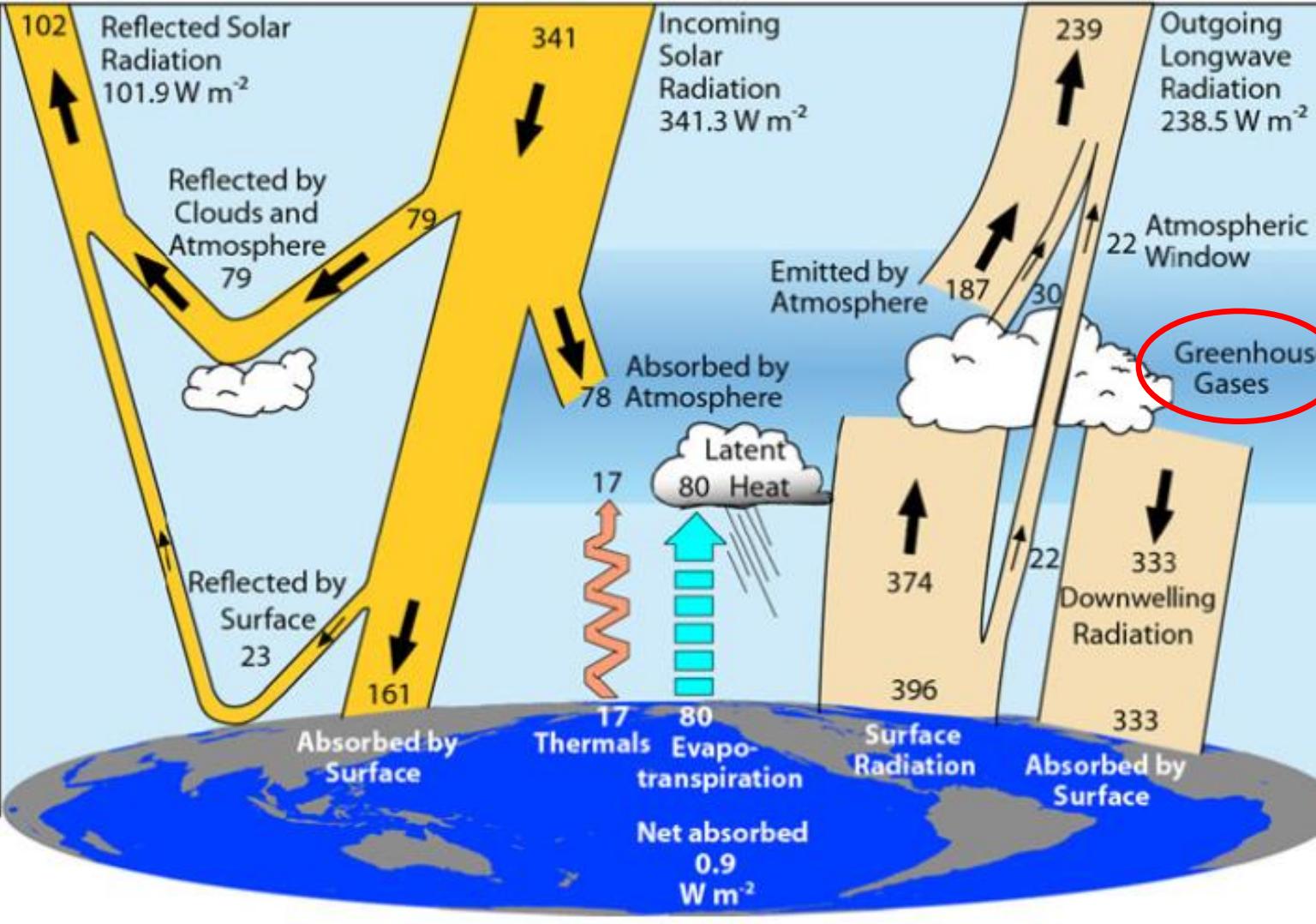
WTO Geneva 29 Jun 2016

Climate Change

Global
surface air
temperature
(relative to
1961-1990
average)

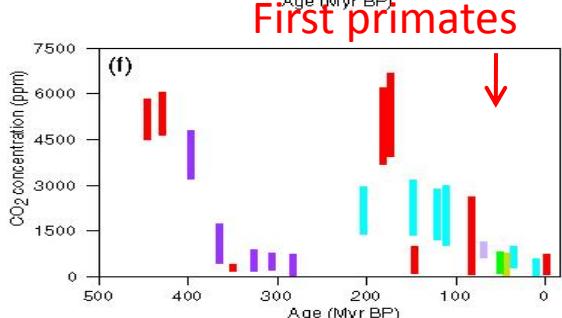
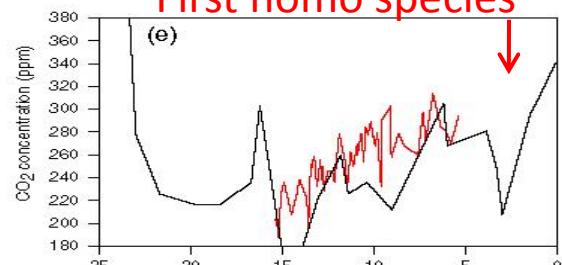
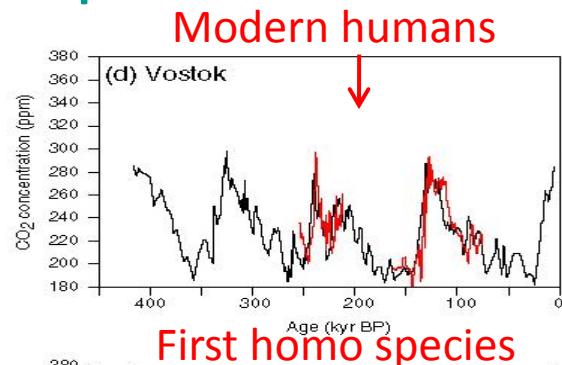
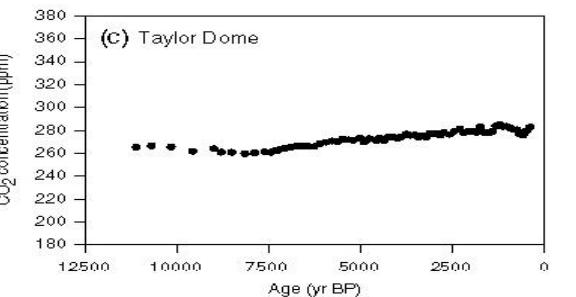
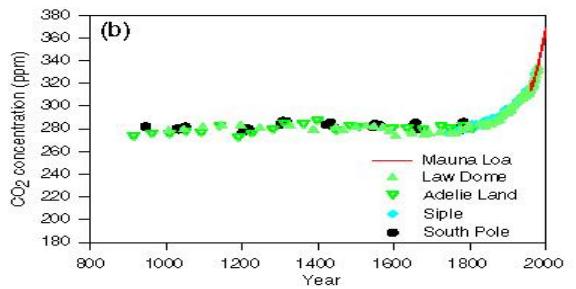
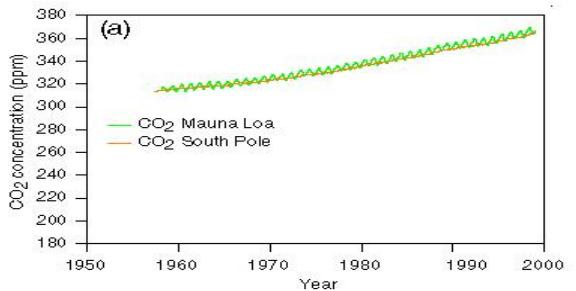
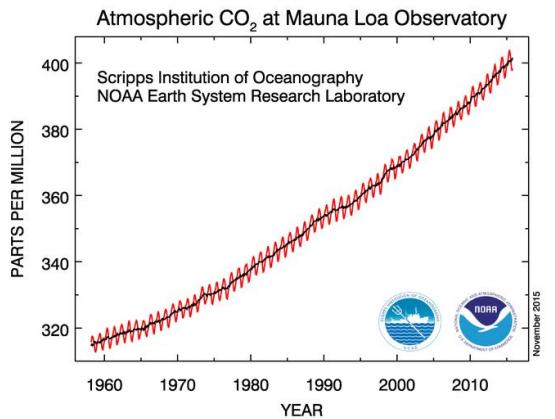
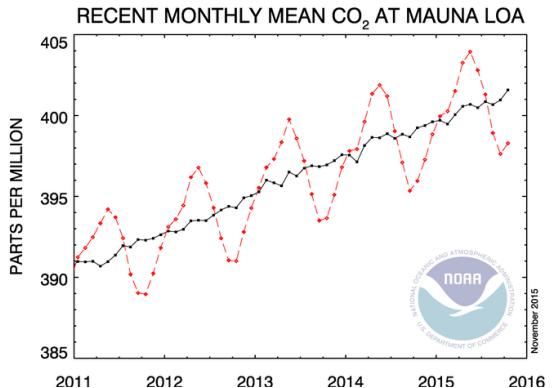


Earth's Energy Budget



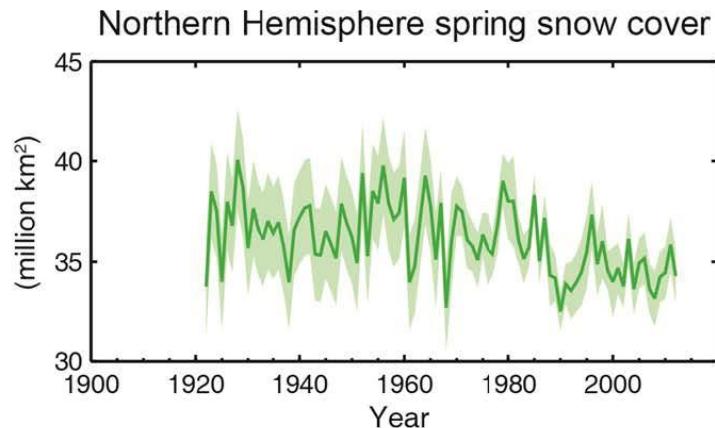
H_2O
 CO_2
 CH_4
 N_2O
+...

Carbon dioxide (CO_2) in the atmosphere

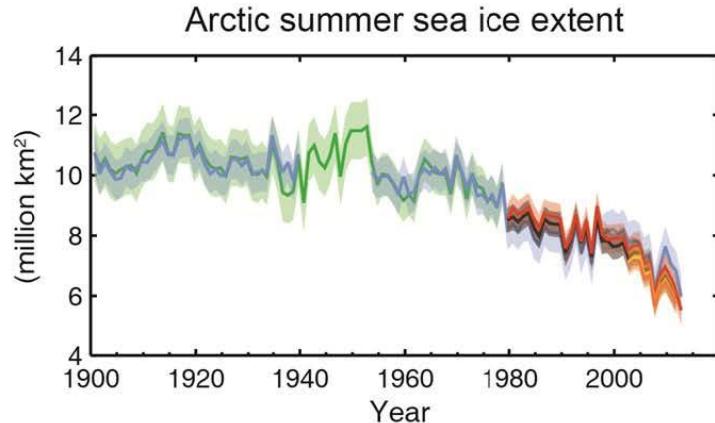


Other evidence for climate change

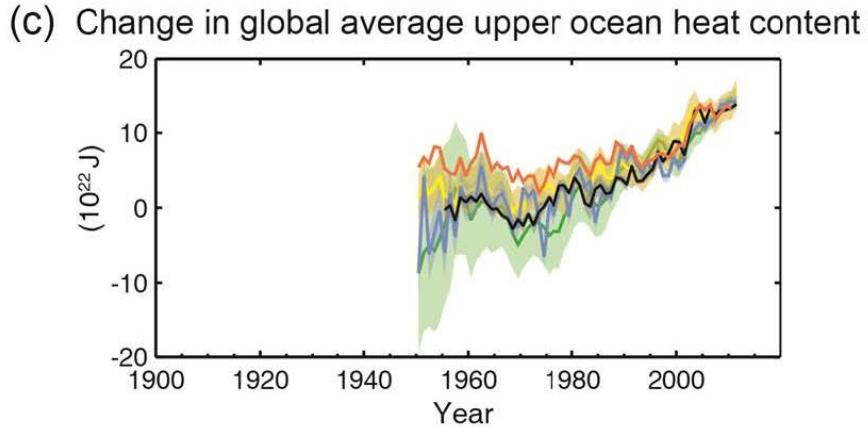
(a)



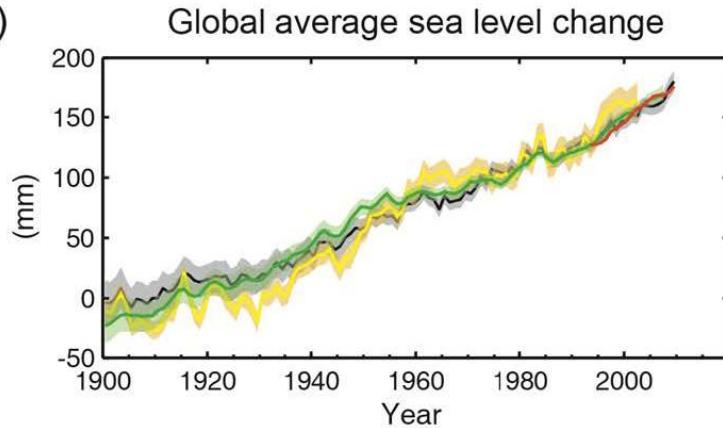
(b)



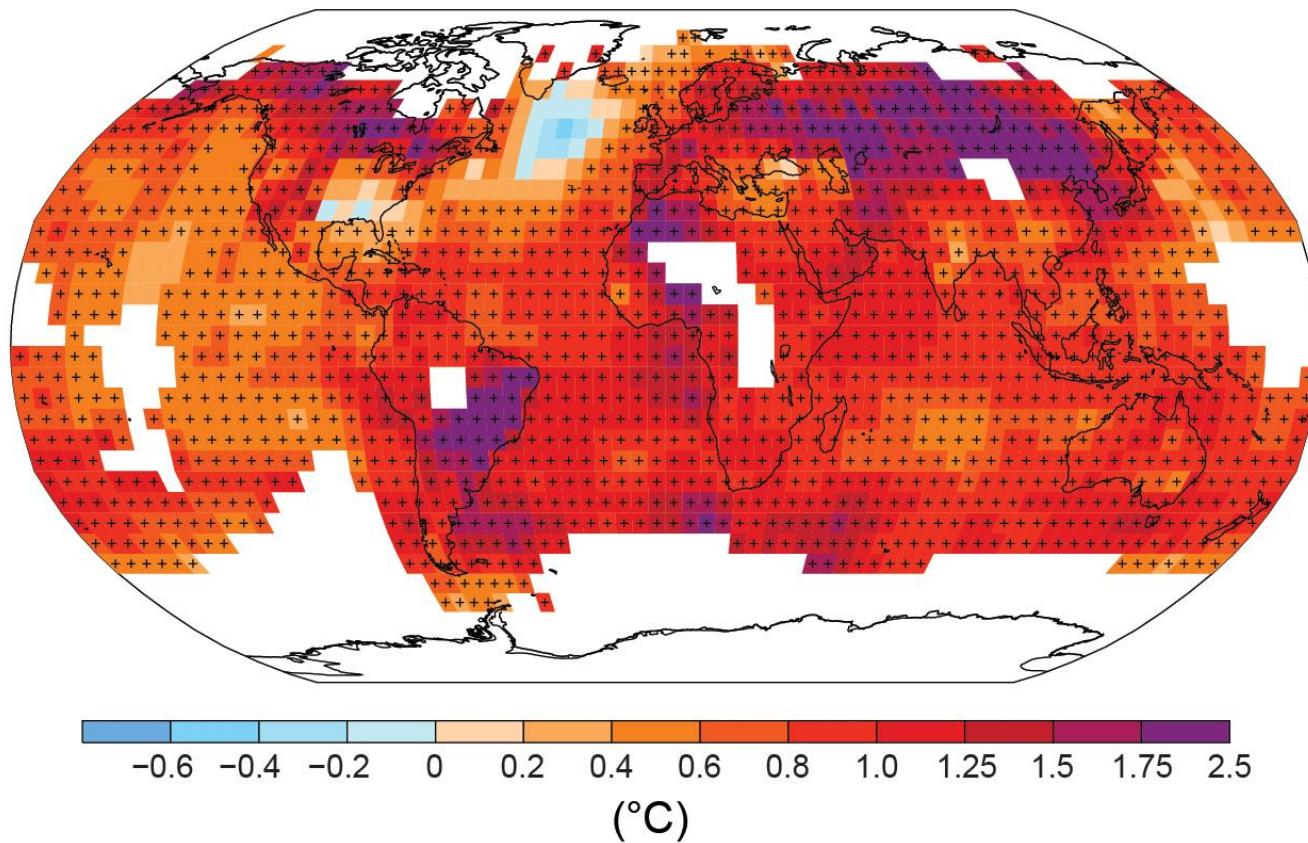
(c)



(d)



Regional variations: observed change in surface temperature 1901-2012



Climate forcing factors

Natural:

- The Sun (variations in energy output; variations in Earth's orbit)
- Particles from volcanoes

From humans:

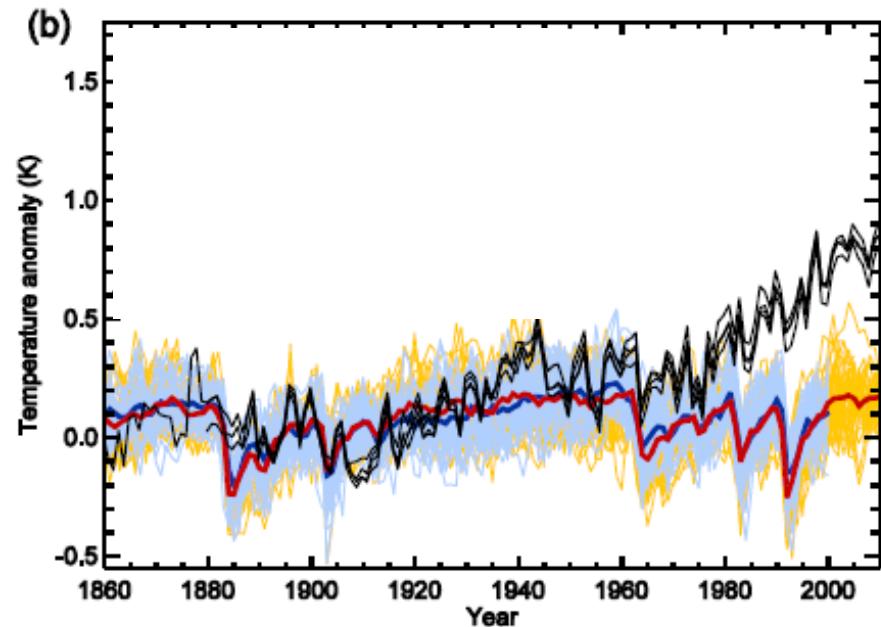
- Greenhouse gases
- Particles from industry
- Land use (surface reflectivity)

within a highly complex and variable climate system

Results from climate models

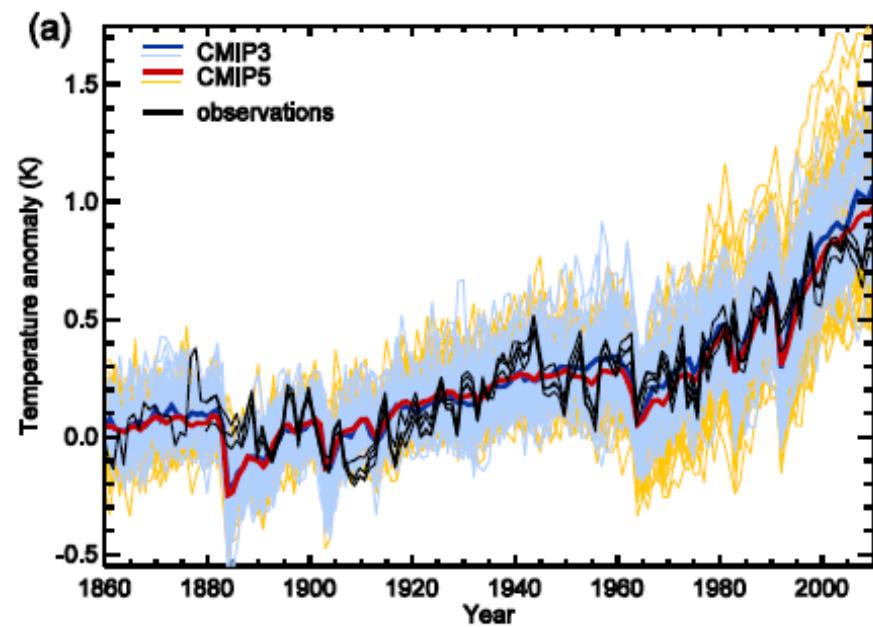
Observations

Models: only natural forcing



Observations

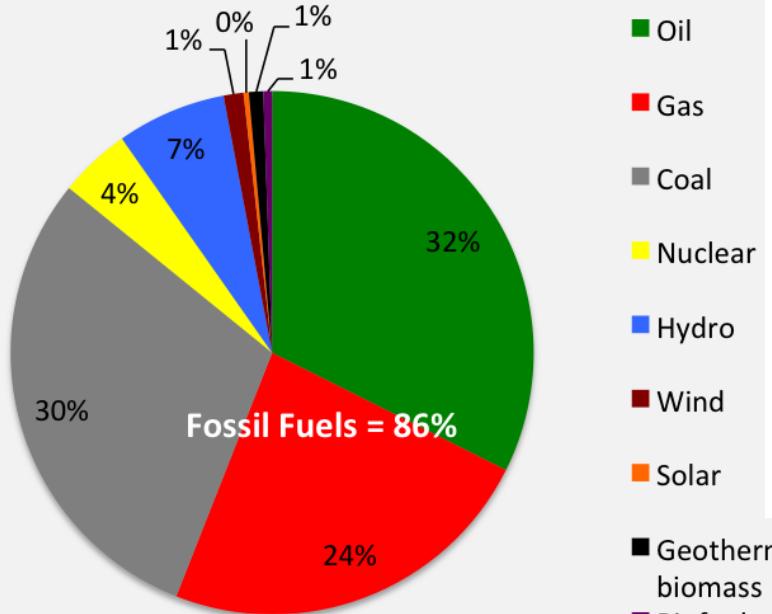
Models: all forcings



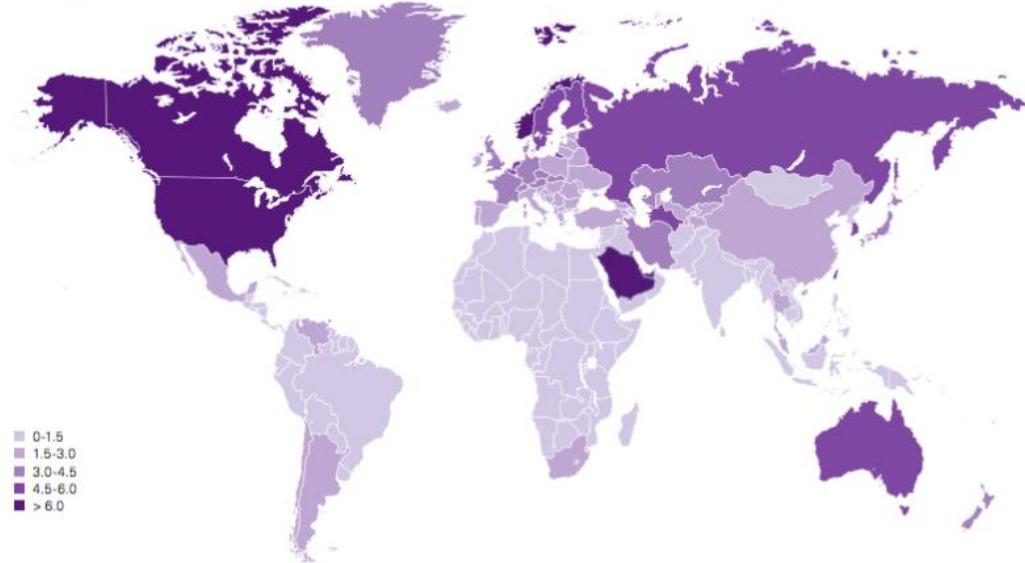
Future climate depends on CO₂ emissions

Currently 86% energy from fossil fuels

Global energy consumption 2014

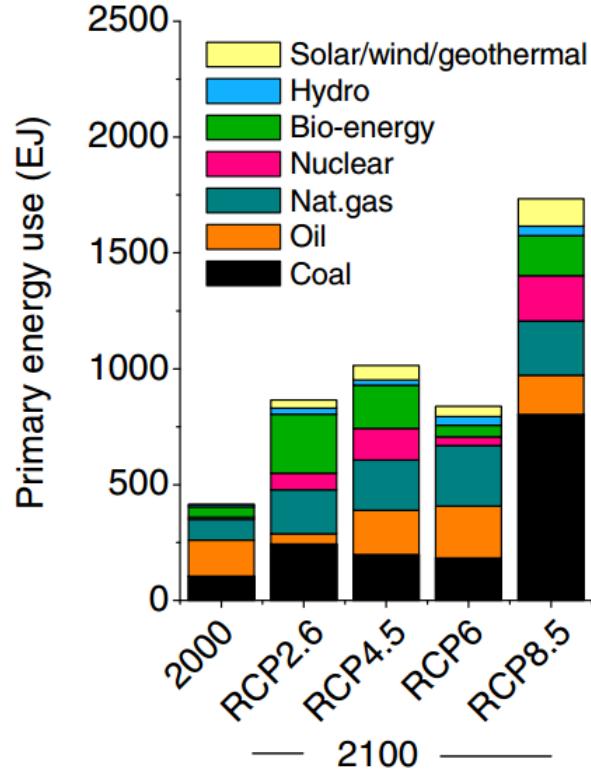


Consumption per capita 2013
Tonnes oil equivalent

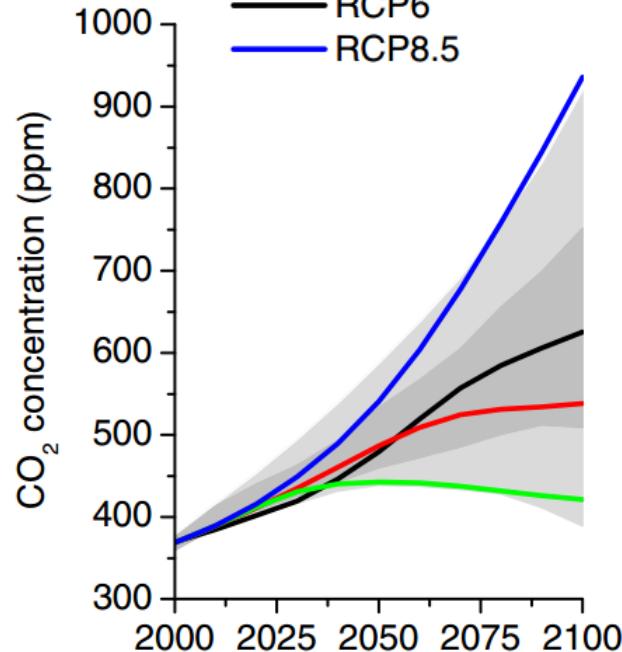
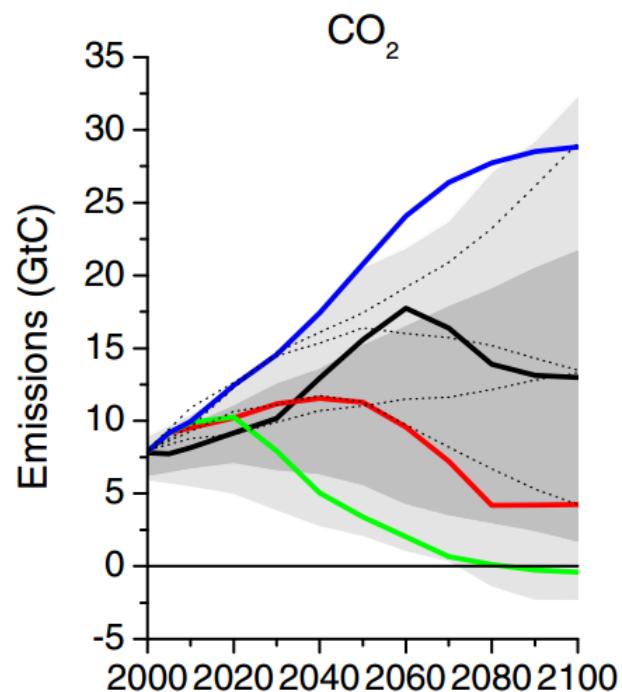


BP Statistical Review of World Energy 2014

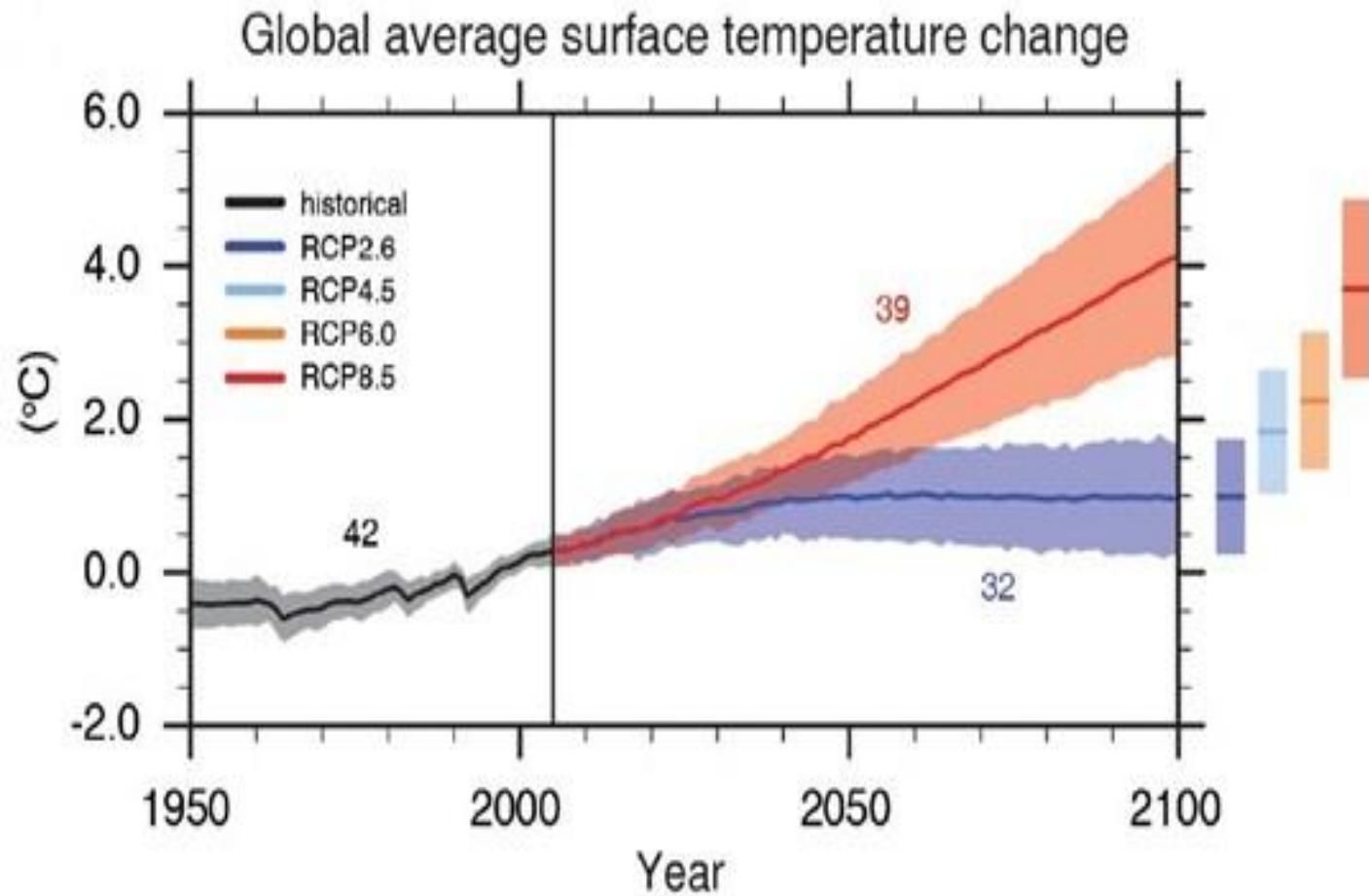
CO_2 projected emissions and concentrations



IPCC Representative Concentration Pathways

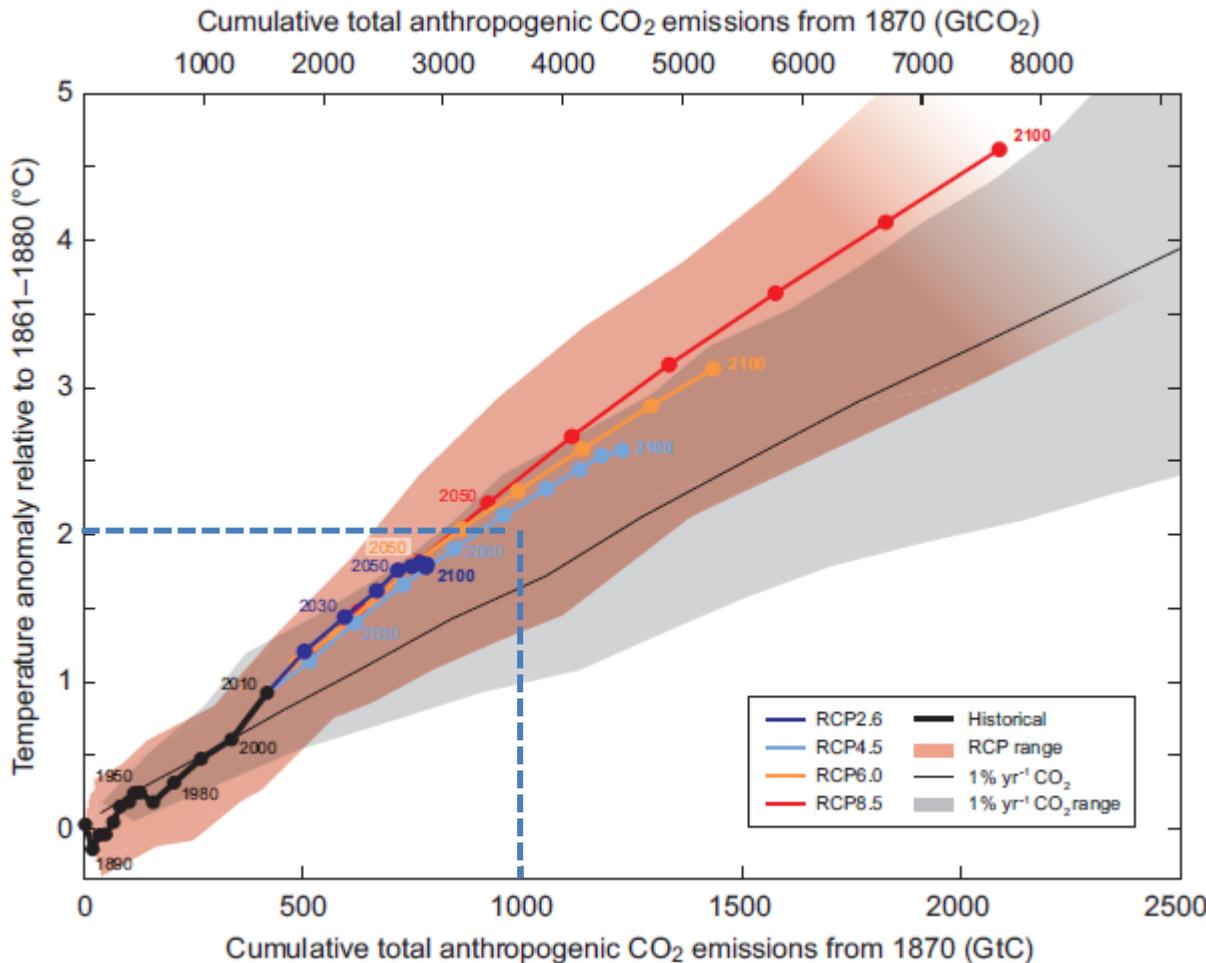


Predicted response in global surface temperature

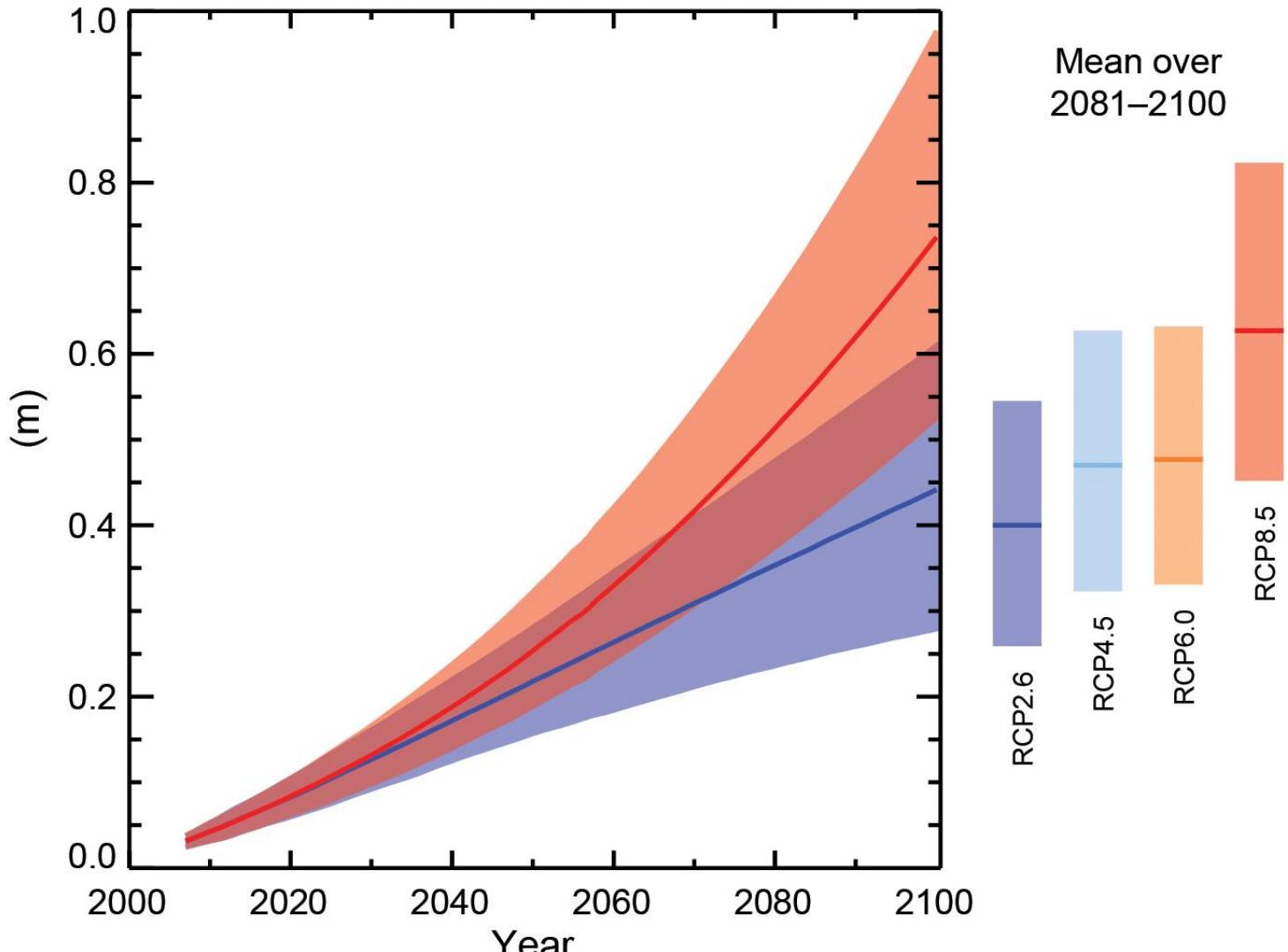


Cumulative carbon emissions

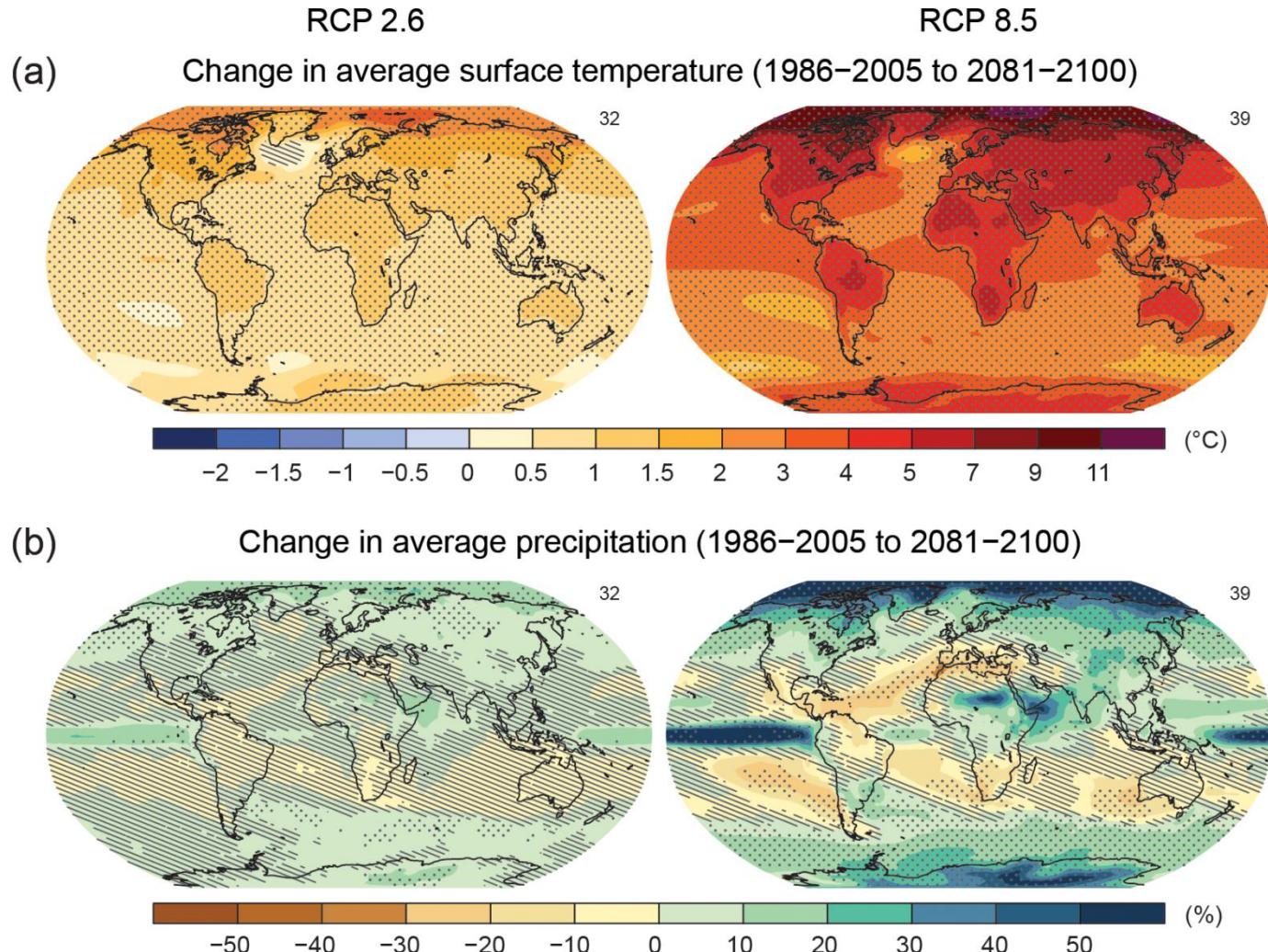
To avoid exceeding
2°C warming total
emissions need to
stay below about a
trillion tonnes



Predicted response in global sea level



Predicted regional responses in temperature & precipitation



Current emissions pathway will result by 2100 in...



2 billion
people with
increased
water scarcity



70-90 million
people/year
affected by river
flooding



50% of plant
species lose
> half habitat

10-12 billion
people/year
exposed to
heatwaves



Cooling
demands 2x



60% of cropland
less suitable for
agriculture



Tackling the climate change problem

By emitting greenhouse gases into the atmosphere we are performing a very dangerous experiment with planet Earth.

What can/should we do?

1. Adapt to the impacts ?

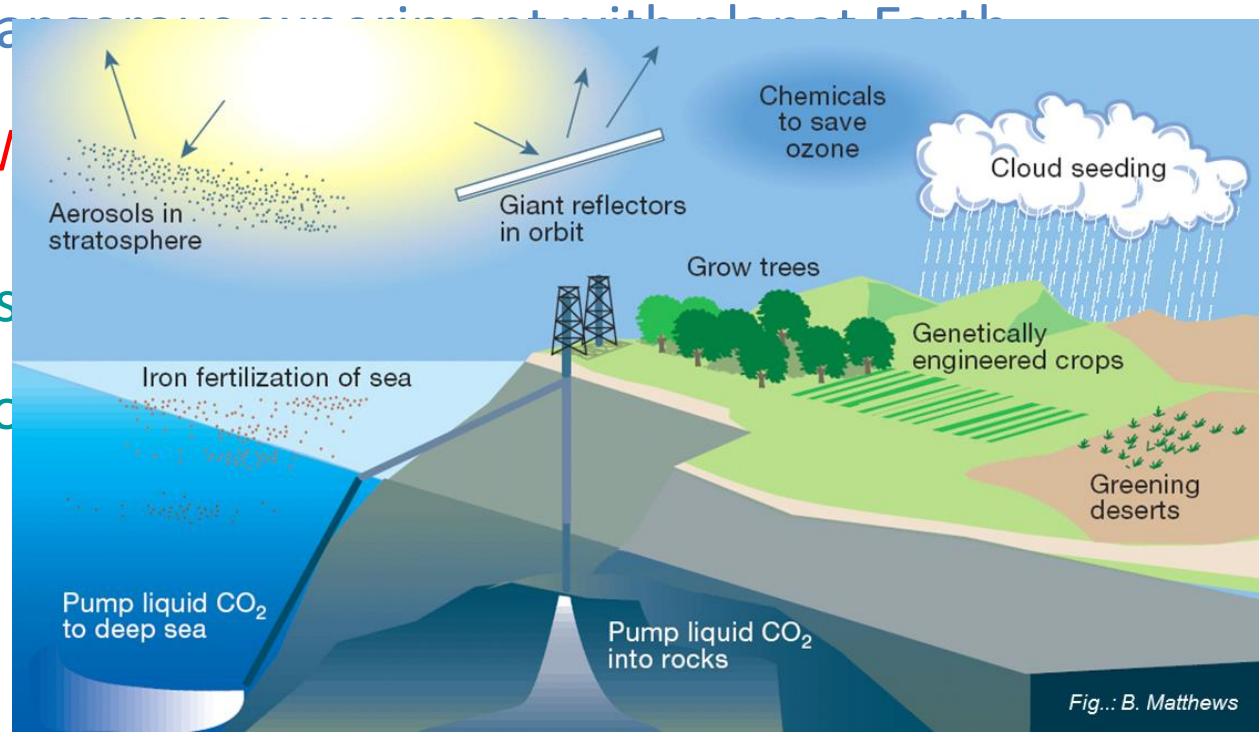


© Bill Hare

Tackling the climate change problem

By emitting greenhouse gases into the atmosphere we are performing a very dangerous experiment.

1. Adapt to the impacts
2. Do something else to



Tackling the climate change problem

By emitting greenhouse gases into the atmosphere we are performing a very dangerous experiment with planet Earth.

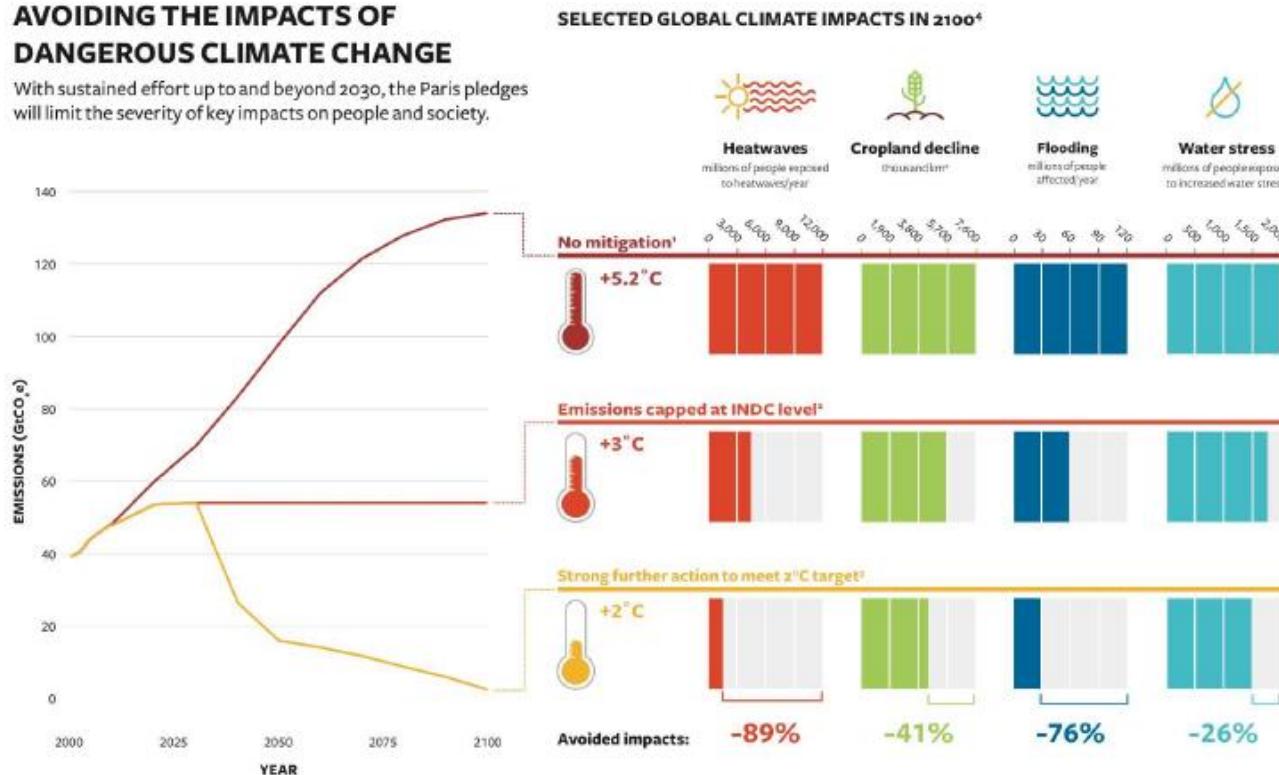
What can/should we do?

1. Adapt to the impacts ?
2. Do something else to compensate (“geoengineering”)?
3. Reduce the emissions of greenhouse gases...

What impacts do different scenarios avoid?

AVOIDING THE IMPACTS OF DANGEROUS CLIMATE CHANGE

With sustained effort up to and beyond 2030, the Paris pledges will limit the severity of key impacts on people and society.





United Nations
Framework Convention on
Climate Change

COP21 Paris

30 Nov – 11 Dec 2015



- UN Framework Convention on Climate Change 21st Conference of the Parties – international discussions on how to limit climate change.
- Beforehand submissions of Intended Nationally-Determined Contributions (INDCs) for 183 countries (97% global population)
- A agreement was reached. Its aims include:



- to keep a global temperature rise this century well below 2°C and to drive efforts to limit the temperature increase even further to 1.5°C above pre-industrial levels.
- to strengthen the ability to deal with the impacts of climate change.
- financial flows will be put in place, thus making stronger action by developing countries ... possible...

An Important Note

To constrain global temperature rise to stay below **any** particular value will require net CO₂ emissions to **cease**.

A lower temperature target requires a faster transition to
NET ZERO emissions



Grantham Annual Lecture at Imperial College 11 April 2016

UN climate chief Christiana Figueres told us that she expects the Paris agreement to come into effect in 2018 – two years earlier than expected

Nations sign historic Paris climate deal

By Matt McGrath
Environment correspondent, New York

© 22 April 2016 | Science & Environment



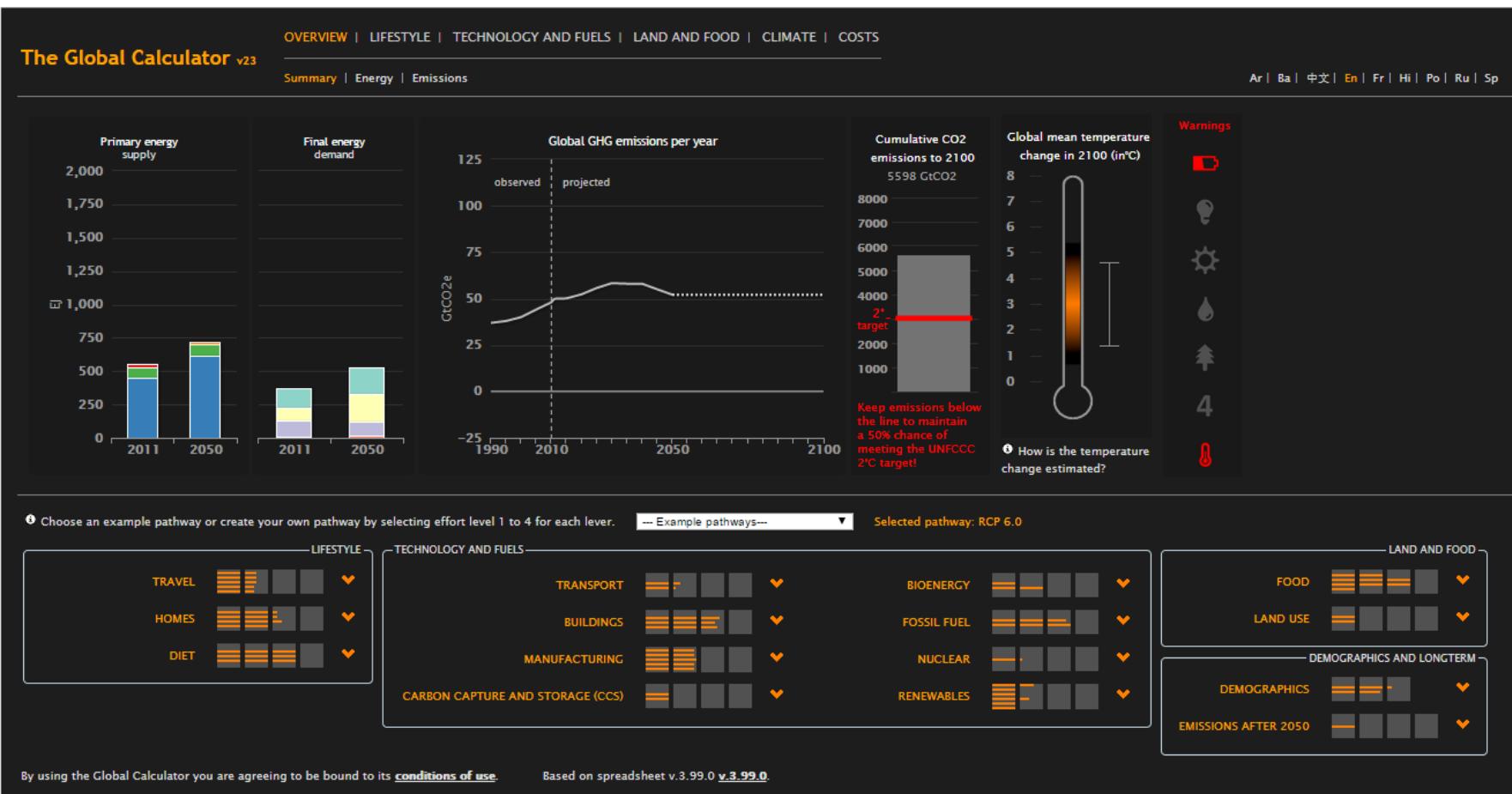
John Kerry held his granddaughter as he signed the book during the signature ceremony for the Paris Agreement

Amid hope and hype, delegates have finished signing the Paris climate agreement at UN headquarters in New York.

Some 171 countries inked the deal today, a record number for a new international treaty.

How might carbon reductions be achieved?

<http://tool.globalcalculator.org/>



Support for innovation in new technologies for decarbonisation



The image shows the homepage of the Mission Innovation website. The header features a green sidebar with "INAUGURAL MISSION", "INNOVATION MINISTERIAL", and "Press Release 2 June 2016". The main title "MISSION INNOVATION" is in large white letters, with the subtitle "Accelerating the Clean Energy Revolution" below it. A central text block states: "Mission Innovation aims to reinvigorate and accelerate global clean energy innovation with the objective to make clean energy widely affordable." Below this, two columns of text discuss the importance of clean energy innovation and the role of Mission Innovation. At the bottom are three buttons: "Learn More About Mission Innovation", "Mission Innovation News & Events", and "Inaugural Mission Innovation Ministerial".

INAUGURAL MISSION
INNOVATION
MINISTERIAL
Press Release
2 June 2016

MISSION INNOVATION

Accelerating the Clean Energy Revolution

Mission Innovation aims to reinvigorate and accelerate global clean energy innovation with the objective to make clean energy widely affordable.

Accelerating widespread clean energy innovation is:

- An indispensable part of an effective, long term global response to our shared climate challenge;
- Necessary to provide affordable and reliable energy for everyone and to promote economic growth; and
- Critical for energy security.

While important progress has been made in cost reduction and deployment of clean energy technologies, the pace of innovation and the scale of transformation and dissemination remains significantly short of what is needed.

Mission Innovation will help accelerate the global clean energy revolution.

[Learn More About Mission Innovation](#)

[Mission Innovation News & Events](#)

[Inaugural Mission Innovation Ministerial](#)

INTRODUCING THE BREAKTHROUGH ENERGY COALITION

THE WORLD NEEDS WIDELY AVAILABLE ENERGY that is reliable, affordable and does not produce carbon. The only way to accomplish that goal is by developing new tools to power the world. That innovation will result from a dramatically scaled up public research pipeline linked to truly patient, flexible investments committed to developing the technologies that will create a new energy mix. The Breakthrough Energy Coalition is working together with a growing group of visionary countries who are significantly increasing their public research pipeline through the Mission Innovation initiative to make that future a reality.

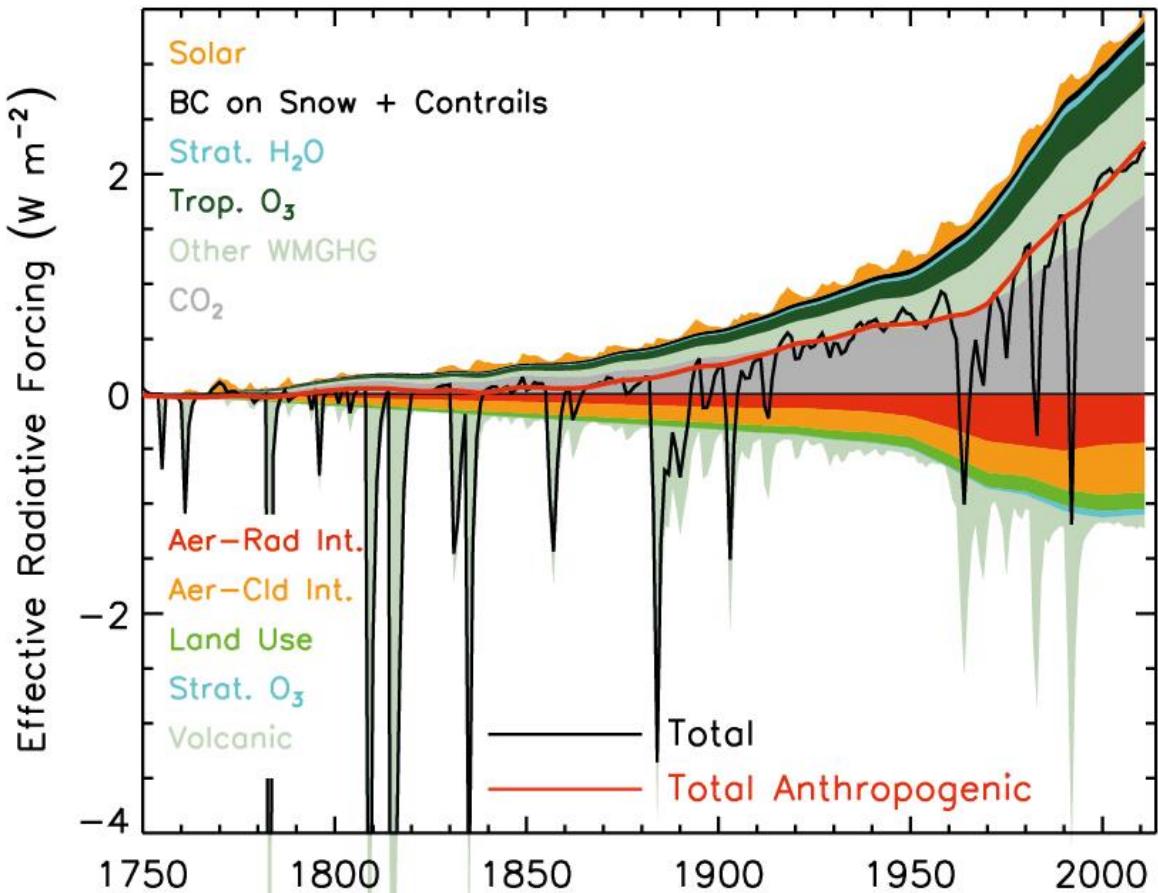
Thank You

Joanna D. Haigh
Imperial College London

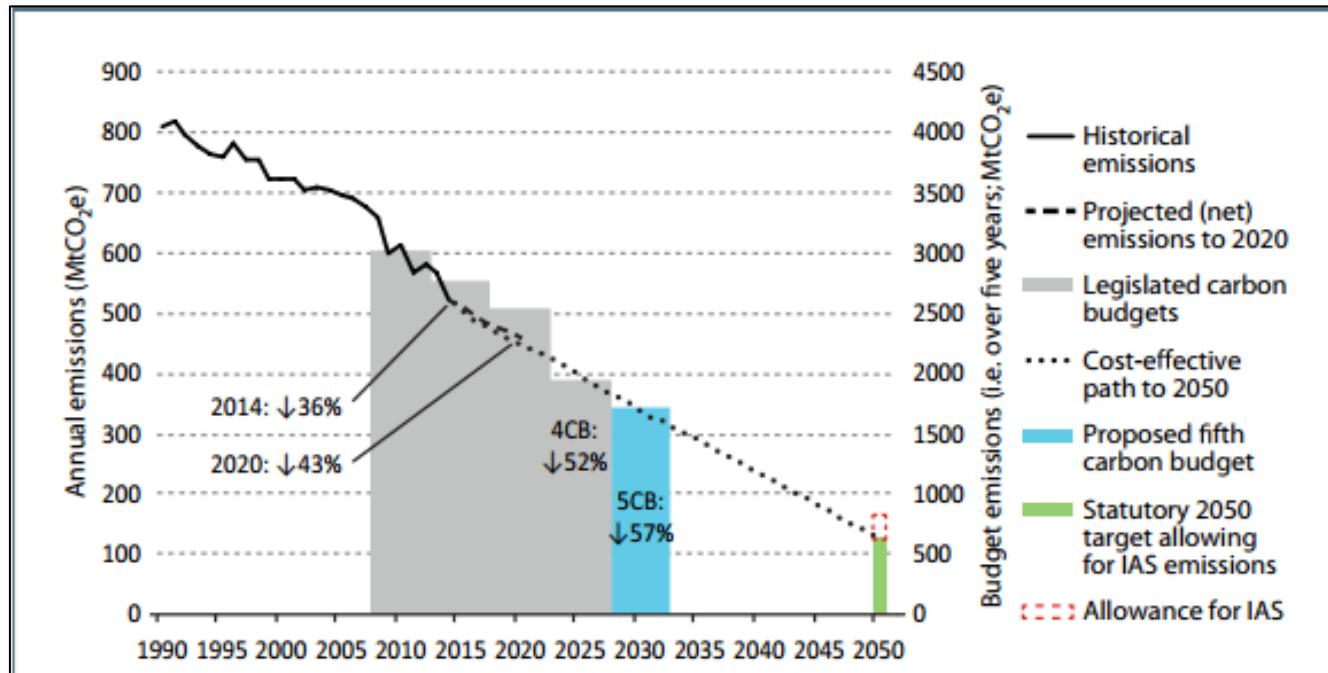
WTO Geneva 29 Jun 2016

“Radiative forcing” by different factors since 1750

IPCC AR5



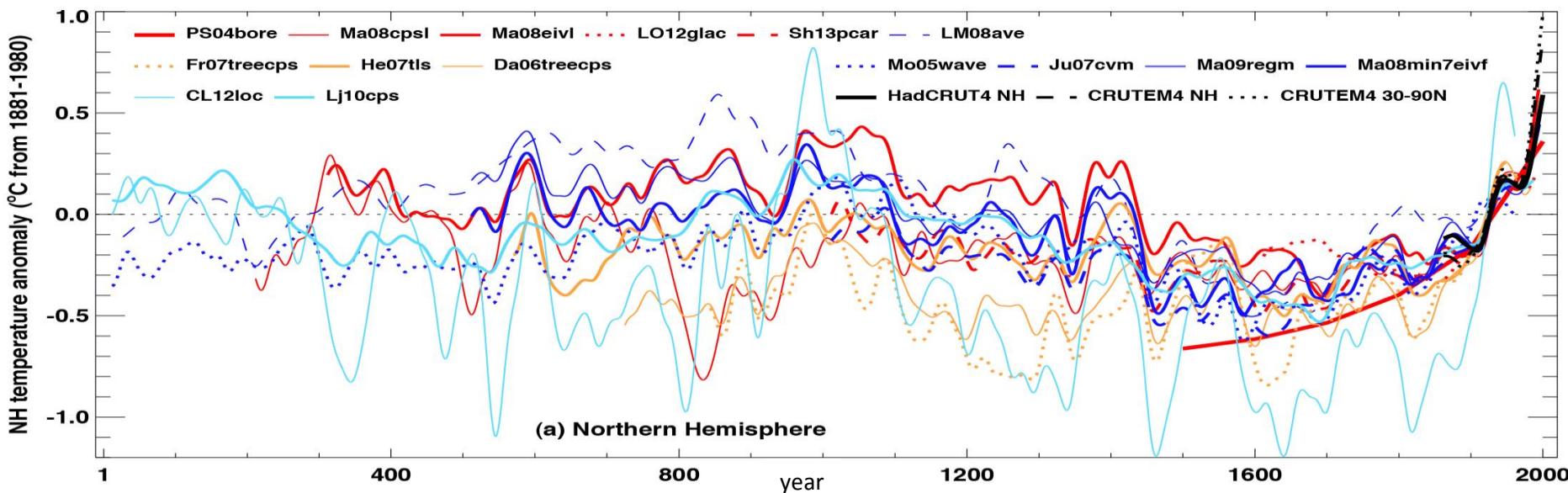
UK carbon budgets – Committee on Climate Change



announced 26 Nov 2015, legislation 2016

Surface air temperature records

Northern Hemisphere – past 2000 years



World power consumption

Globally total current human power
consumption 15,000,000,000,000 W

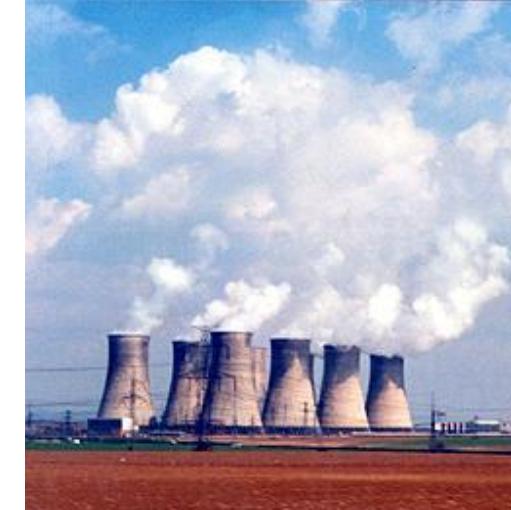
equivalent 670 hpp

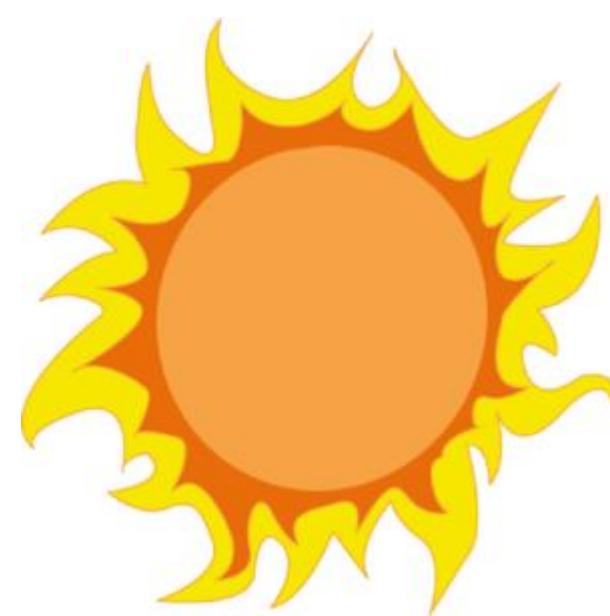


World's largest nuclear
reactor (Japan)
8,000,000,000 W

equivalent 0.4 hpp

Three Gorges dam hydroelectric plant (China)
1 huge power plant (hpp) 22,500,000,000W





Energy from the Sun

Solar power
absorbed by Earth is
120,000,000,000,000,000 W

about 5 million hpp
or 7000 times current total global power consumption