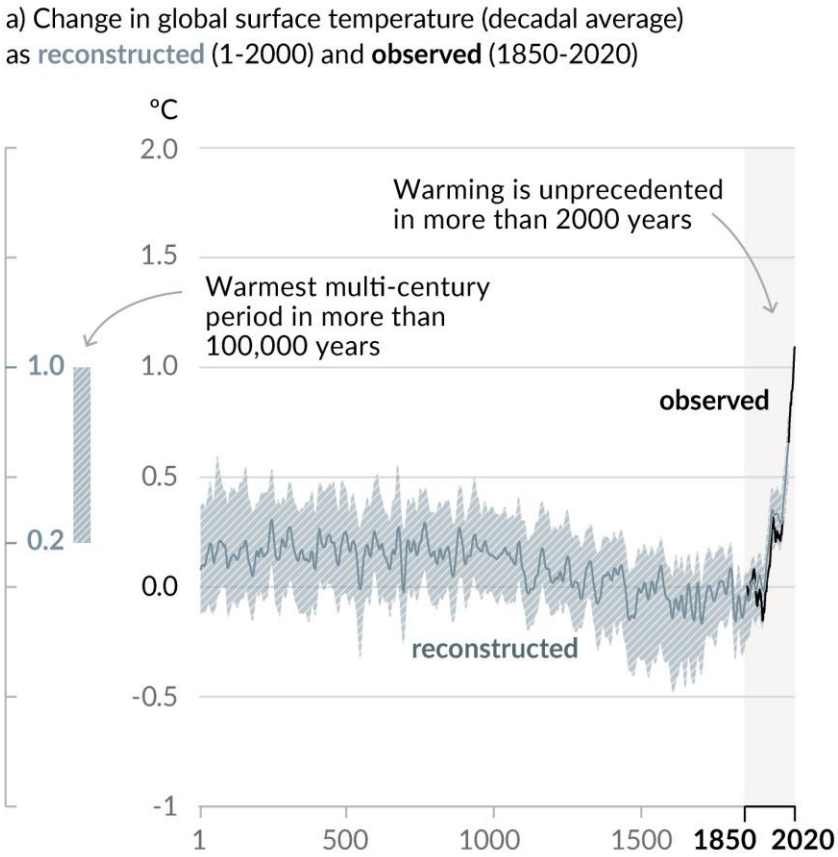


Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

https://www.ipcc.ch/report/ar6/wg1/
Summary for Policymakers

Figure SPM.1

Factors which force climate to change

Natural:

- volcanic eruptions
- solar radiation

Humans:

- greenhouse gas emissions
- industrial pollution
- agriculture and land use

Responses which can reduce or enhance surface warming (or cooling)

- changes in humidity, clouds and ice
- heat storage by oceans
- natural variations & “noise”

b) Change in global surface temperature (annual average) as **observed** and simulated using **human & natural** and **only natural** factors (both 1850-2020)

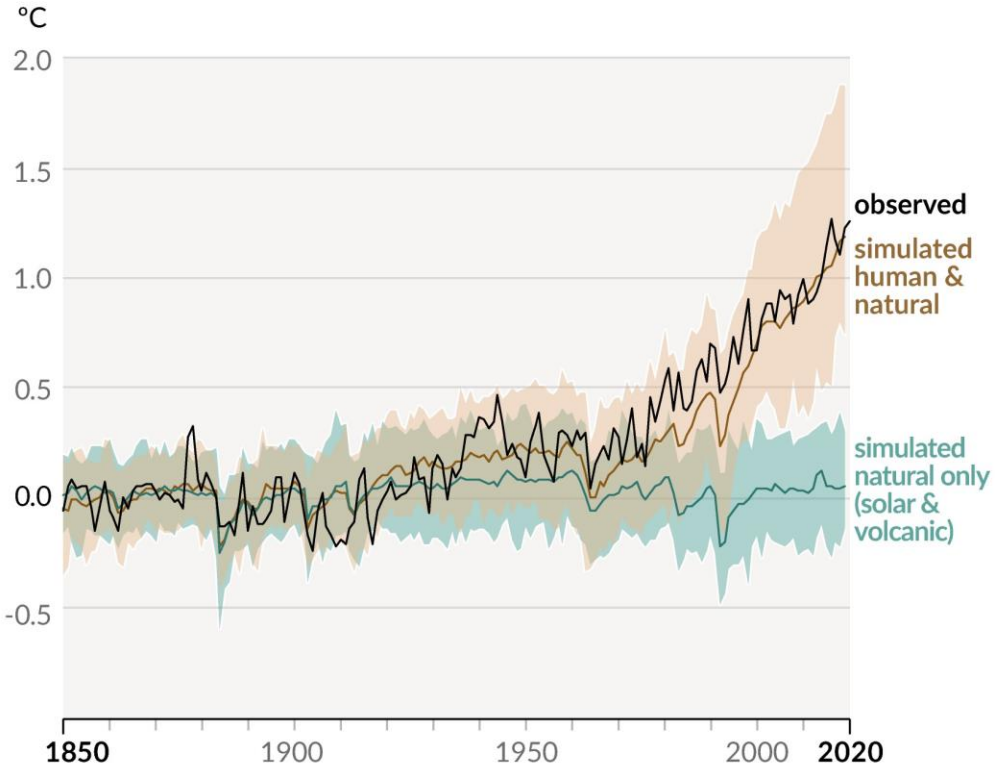


Figure SPM.1

Greenhouse Gases in the atmosphere

nitrogen (78%)

oxygen (21%)

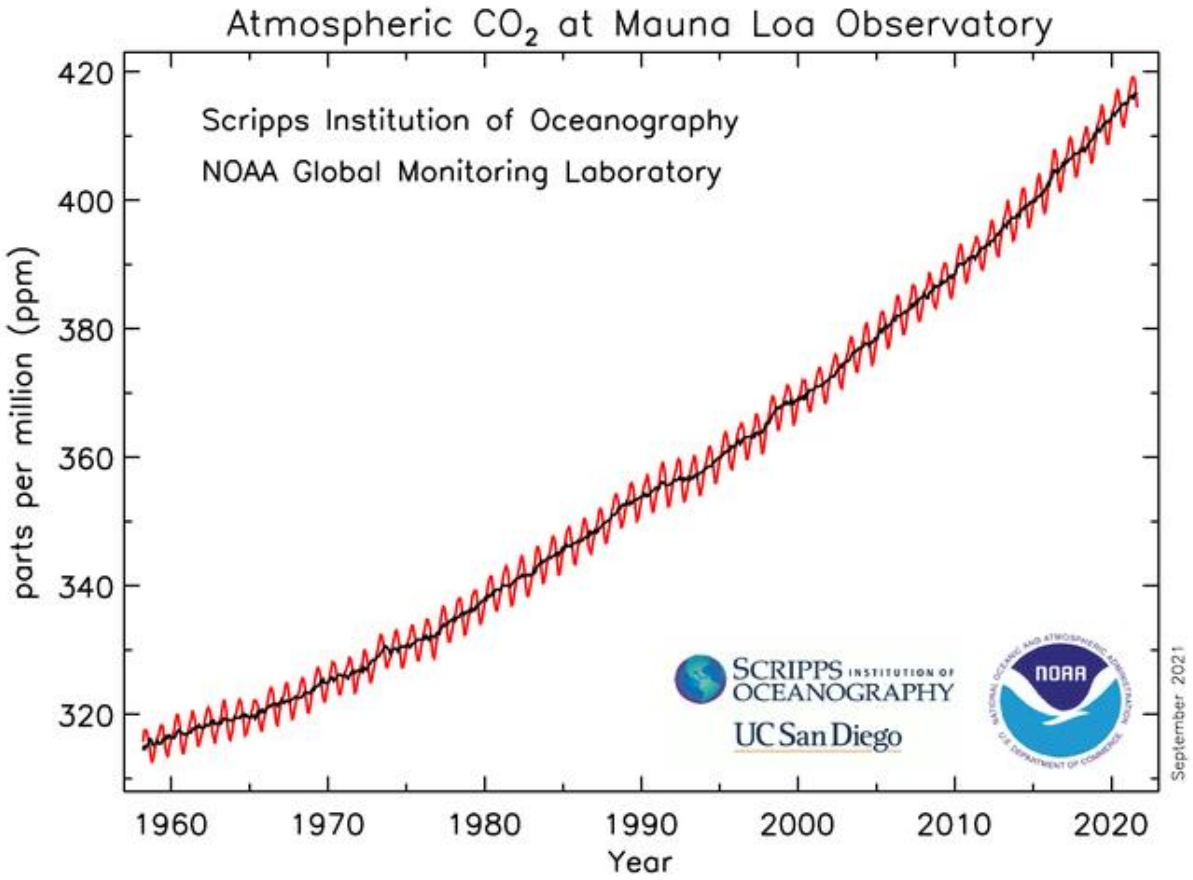
argon (0.9%)

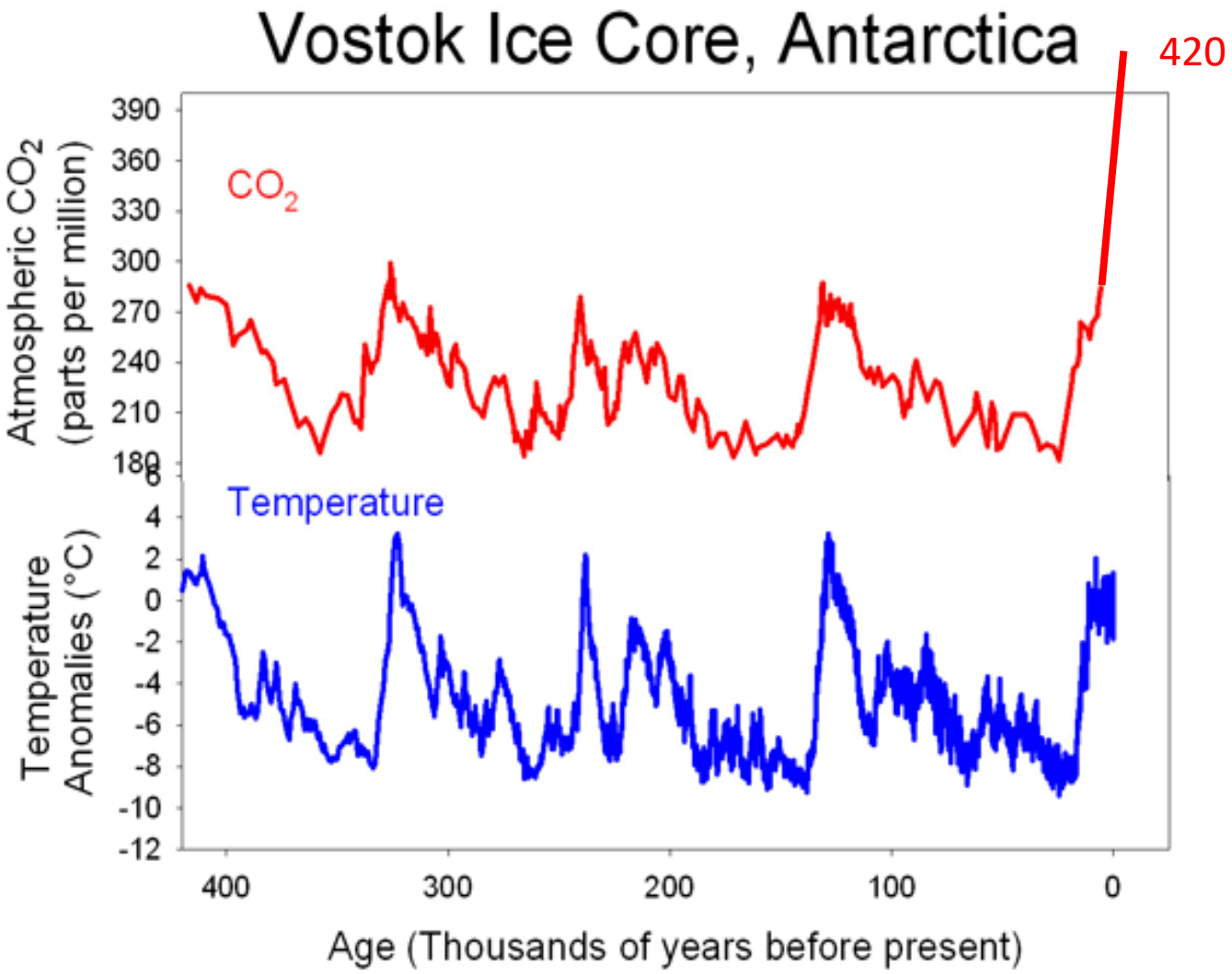
carbon dioxide (0.04%)

.....

plus water vapour (0-4%)

Atmospheric carbon dioxide concentration





Glacial cycles

- Initiated by changes in Earth's orbit
- Amplified by CO_2 and CH_4

Rate of warming

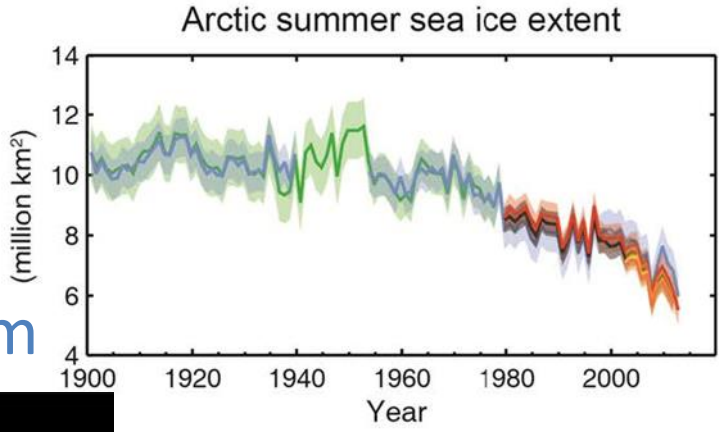
Approx 5000 years for global temperature to rise by about 5°C at end of each glacial period.

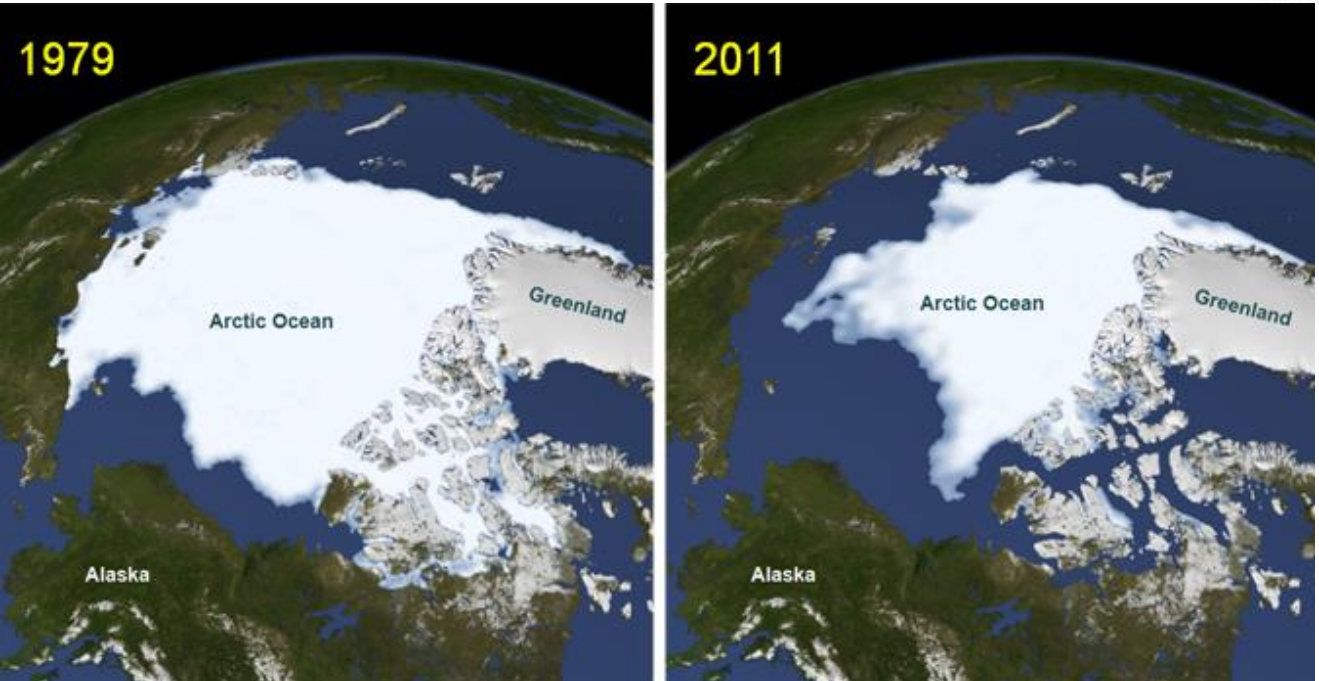
It has risen by about 1°C over the past 100 years: 10 times the rate.

CO_2 now higher than in 3 million years.

Other evidence for climate change:

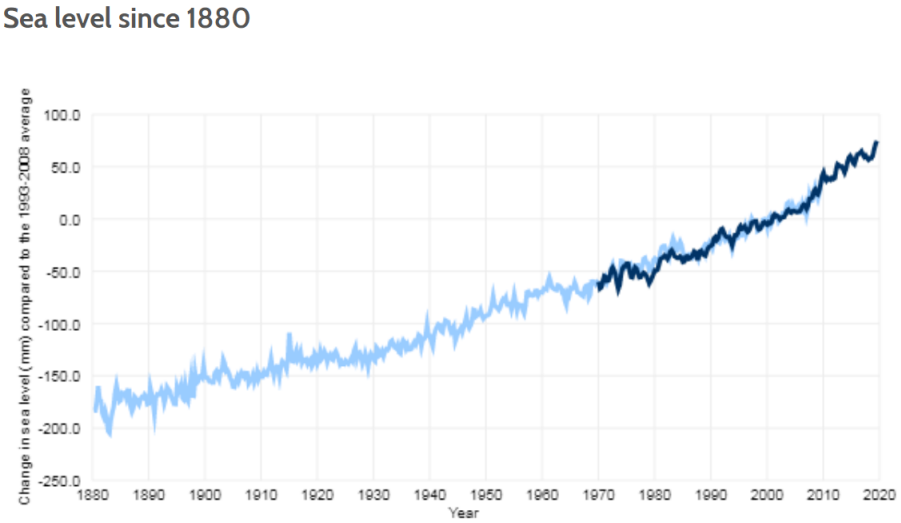
Area of Arctic sea ice at summer minimum





NB
Less ice cover → darker surface → less reflection of solar energy → more warming

Other evidence for climate change: Sea Level rise



Lindsey 2019

Mainly due to:

- thermal expansion of oceans
- melting of ice on land (Antarctic & Greenland ice sheets and global glaciers)

Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes

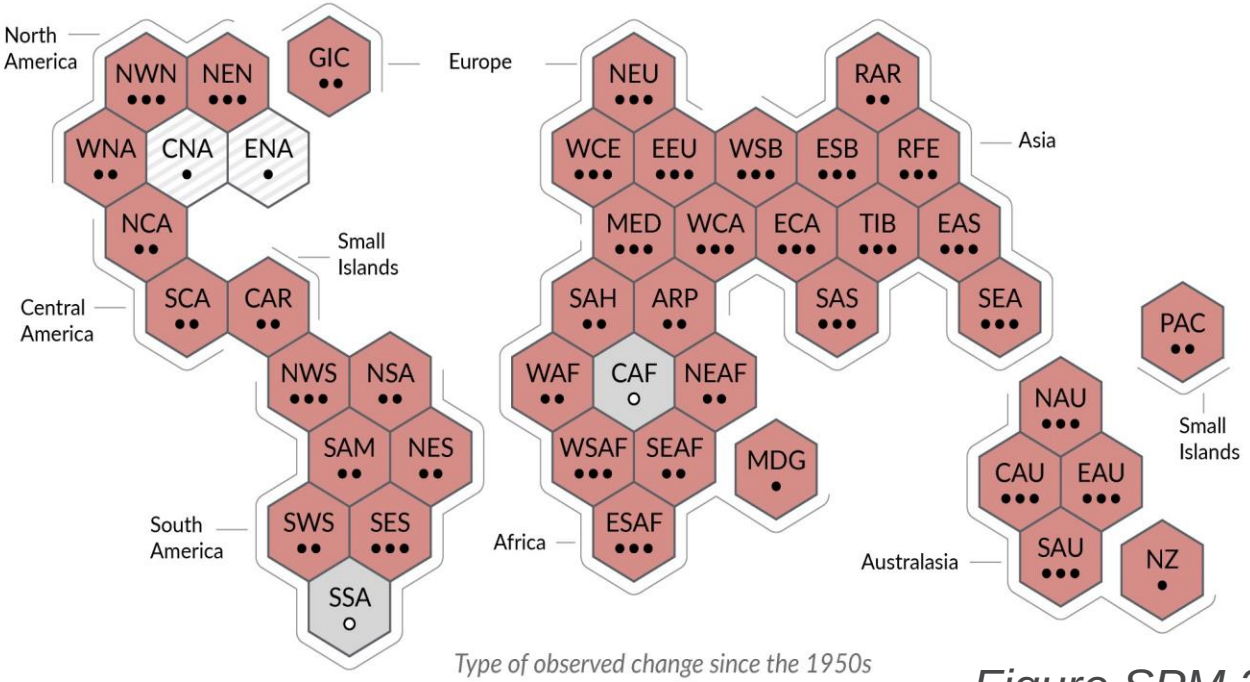
Observed changes in hot extremes

Type of observed change
in hot extremes

- Increase (41)
- Decrease (0)
- Low agreement in the type of change (2)
- Limited data and/or literature (2)

Confidence in human contribution
to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence



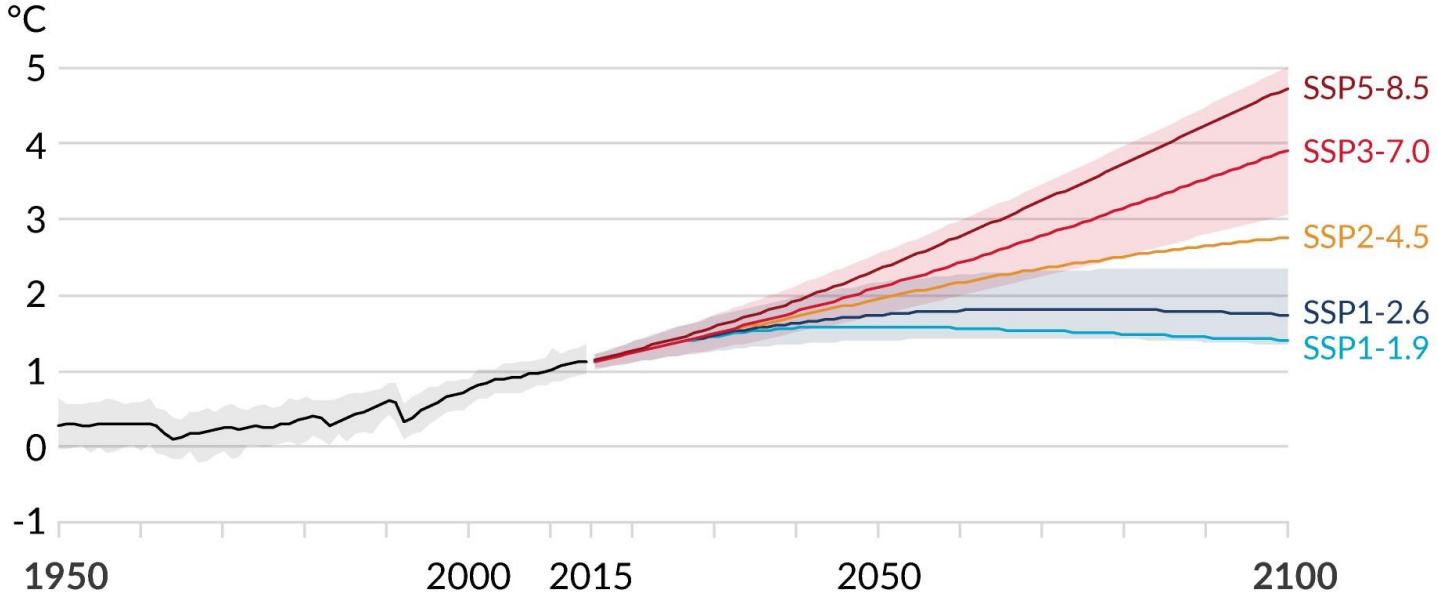
Type of observed change since the 1950s

Figure SPM.3

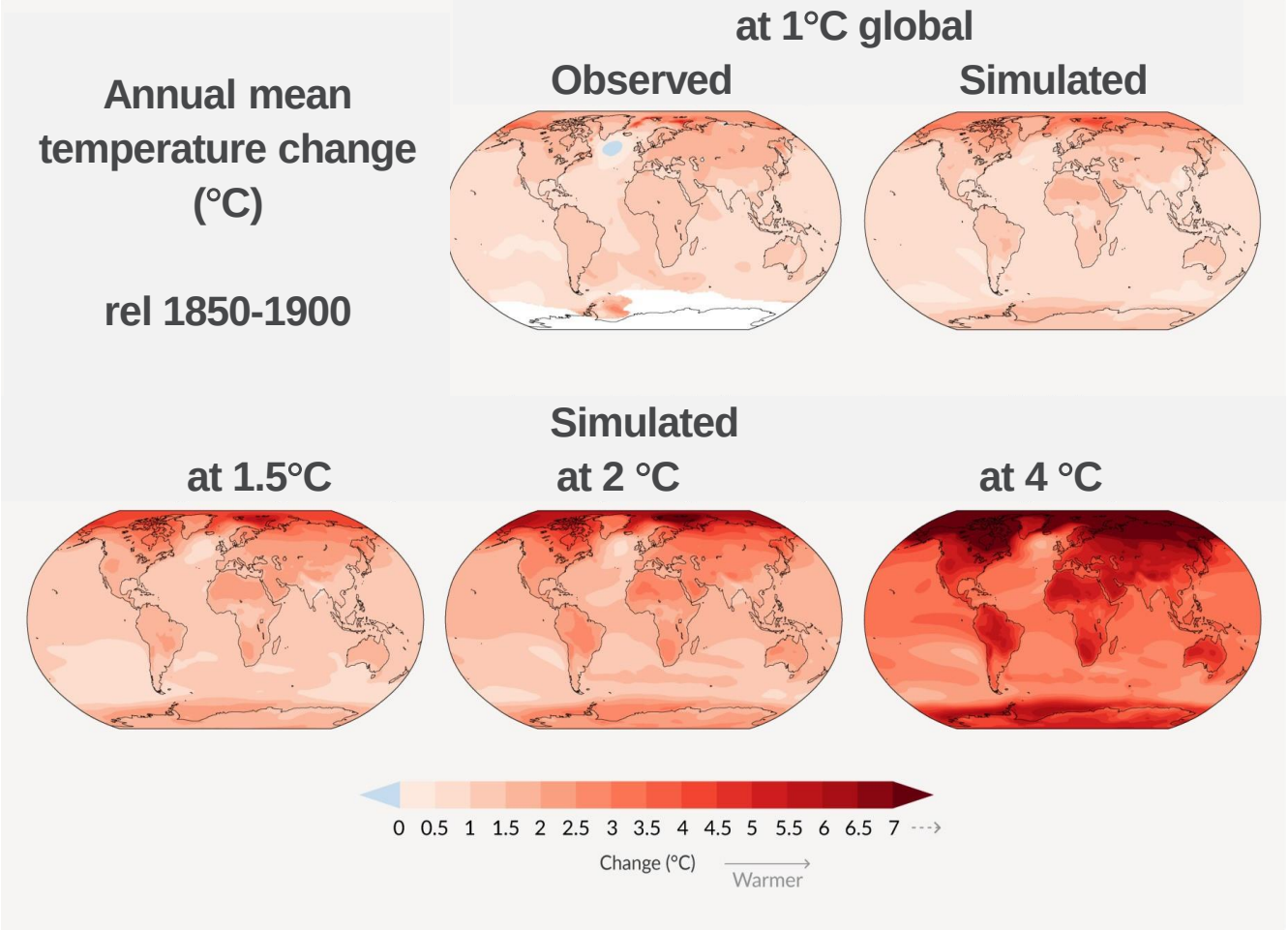
Human activities affect all the major climate system components, with some responding over decades and others over centuries

Figure SPM.8

a) Global surface temperature change relative to 1850-1900



Using “shared socioeconomic pathways” assumptions on future emissions



With every increment of global warming, changes get larger in regional mean temperature

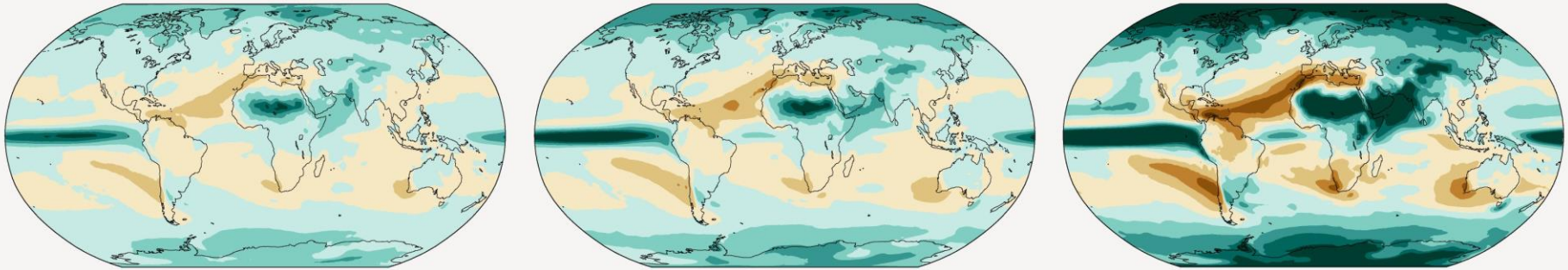
Figure SPM.5

Annual mean precipitation change (%) rel 1850-1900

With every increment of global warming, changes get larger in regional mean precipitation

Simulated

at 1.5°C **at 2 °C** **at 4 °C**



Relatively small absolute changes may appear as large % changes in regions with dry baseline conditions

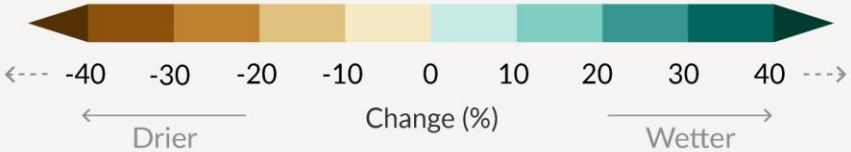
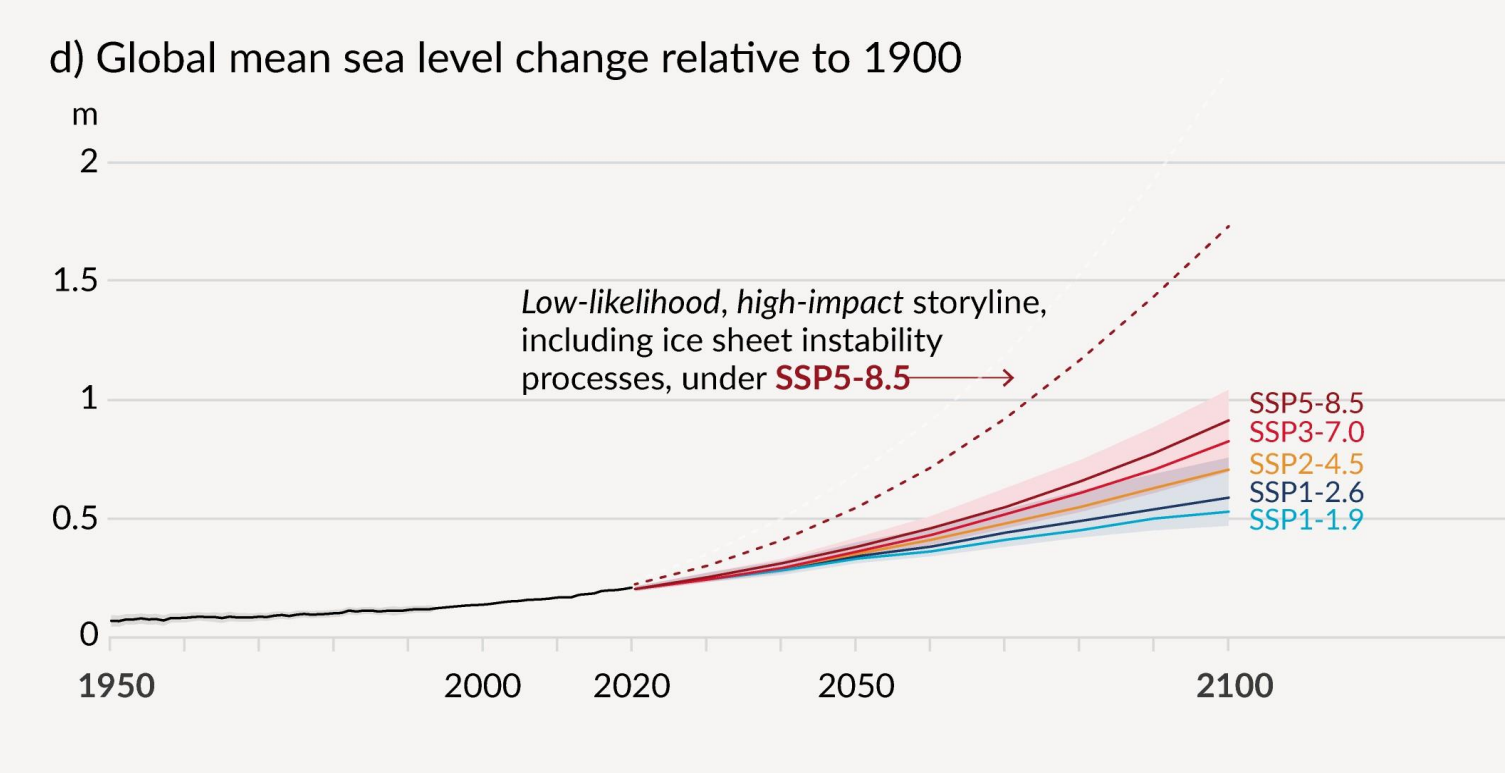


Figure SPM.5

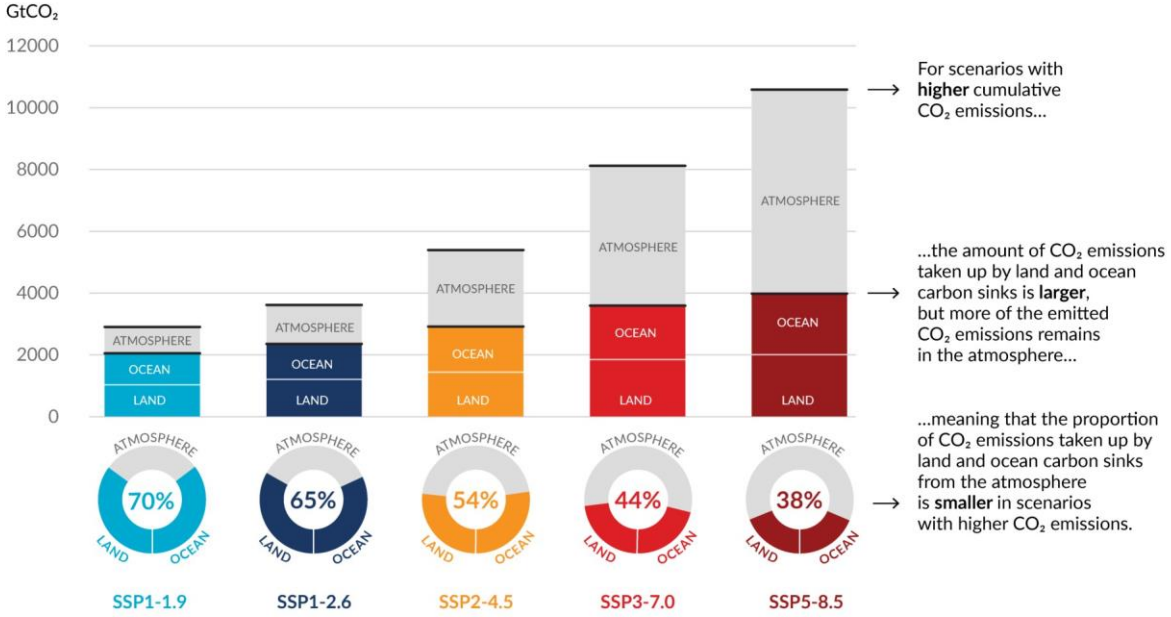
Figure SPM.8


d) Global mean sea level change relative to 1900
m
2
1.5
1
0.5
0
1950
2000
2020
2050
2100
Low-likelihood, high-impact storyline, including ice sheet instability processes, under **SSP5-8.5**
SSP5-8.5
SSP3-7.0
SSP2-4.5
SSP1-2.6
SSP1-1.9

The proportion of CO_2 emissions taken up by land and ocean carbon sinks is smaller in scenarios with higher cumulative CO_2 emissions

Figure SPM.7

Total cumulative CO_2 emissions **taken up by land and oceans** (colours) and remaining in the atmosphere (grey) under the five illustrative scenarios from 1850 to 2100



Projected changes in extremes are larger in frequency and intensity with every additional increment of global warming

For example:

- Hot extremes (frequency)

A temperature that occurred once per decade during 1850-1900
now occurs 2.8 times per decade
will occur 4.1 times per decade at 1.5°C global warming.

- Heavy precipitation (intensity)

A once per decade heavy precipitation event
is 6.7% heavier now than during 1850-1900
will be 10.5% heavier at 1.5°C global warming

see Figure SPM.6

1.5C of warming VS 2C of warming

Heatwaves

1.5C	2C
Up to 1.1 months	Up to 1.5 months

Freshwater

*availability in the Mediterranean**

1.5C	2C
↓ 9%	↓ 17%

Heavy rainfall

*increase in intensity**

1.5C	2C
↑ 5%	↑ 7%

Crop yields

*in tropical regions**

1.5C	2C
Wheat production down ↓ 9%	Wheat production down ↓ 16%
Maize production down ↓ 3%	Maize production down ↓ 6%
Soy production up ↑ 6%	Soy production up ↑ 7%
Rice production up ↑ 6%	Rice production up ↑ 6%

Sea level rise

by 2100 relative to 2000

1.5C	2C
↑ 40cm	↑ 50cm

Coral bleaching

from 2050 onwards

1.5C	2C
90% of reefs at risk	98% of reefs at risk

CarbonBrief
CLEAR ON CLIMATE

*relative to 1986-2005
bit.ly/1point5Cvs2C

All data from Schleussner, C. et al., (2016)
Coral /wheat/maize/rice icons: © yyang/T-Kot/Marnikus/Worraket & Shutterstock.com

Other impacts of current emissions pathway by 2100

2 billion people with increased water scarcity

10-12 billion person-exposures to heatwaves per year

70-90 million people/year affected by river flooding

Cooling demands 2x

50% of plant species lose > half habitat

60% of cropland less suitable for agriculture

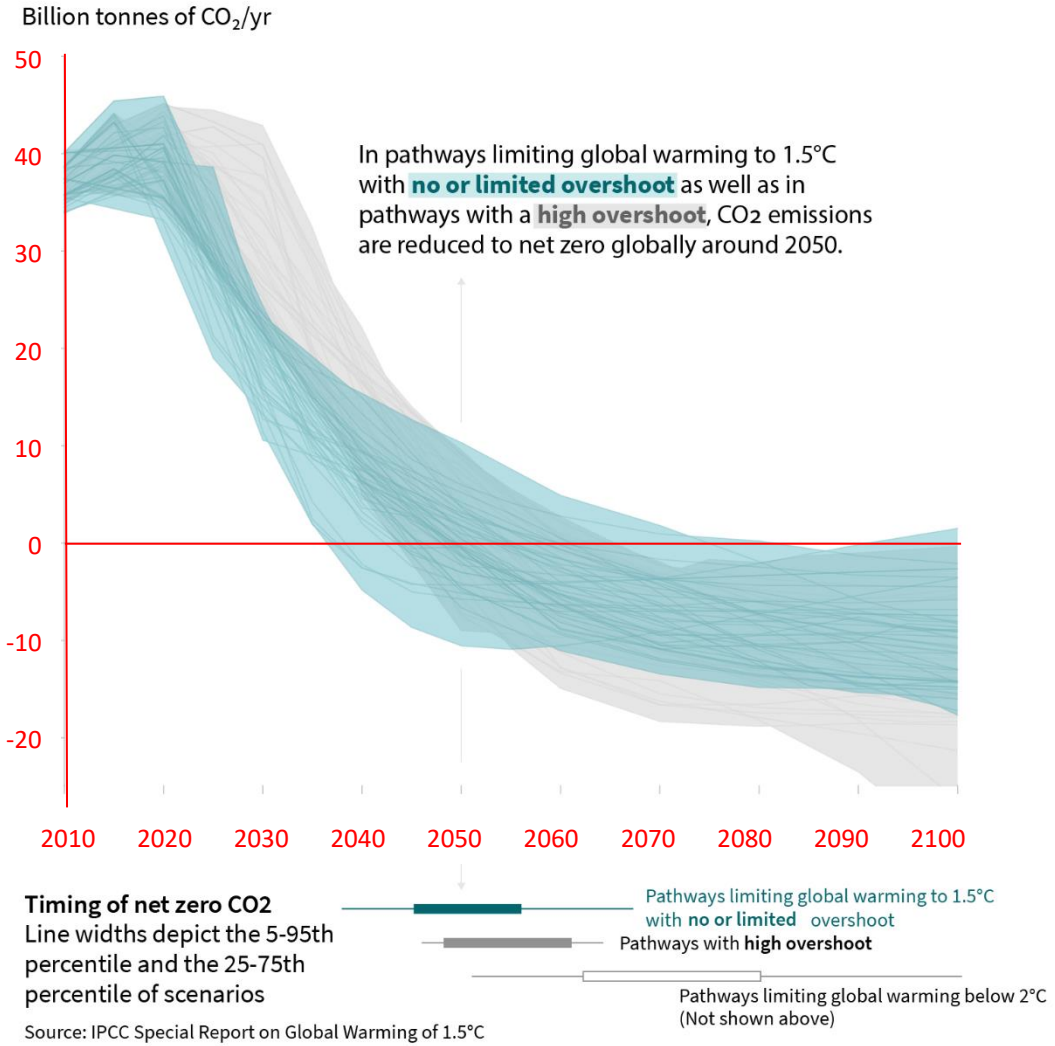
AVOID2 (2015)

Available carbon budget

- CO_2 long-lived in atmosphere. Global temperature rise is proportional to total accumulated CO_2 emissions.
- To constrain global temperature rise below any particular value will require net greenhouse gas emissions to stop by some date.
- Greater current emissions $\rightarrow$ sooner need to stop.

“Net Zero”

If any emissions continue then carbon dioxide needs to be removed from the atmosphere at the same rate as it is put in.



Global CO_2 pathways which limit warming to 1.5°C

- All reach net-zero CO_2 around mid-century
- Delay in peak means greater capture needed later

IPCC October 2018

Global emissions gap
between what is happening and what is required

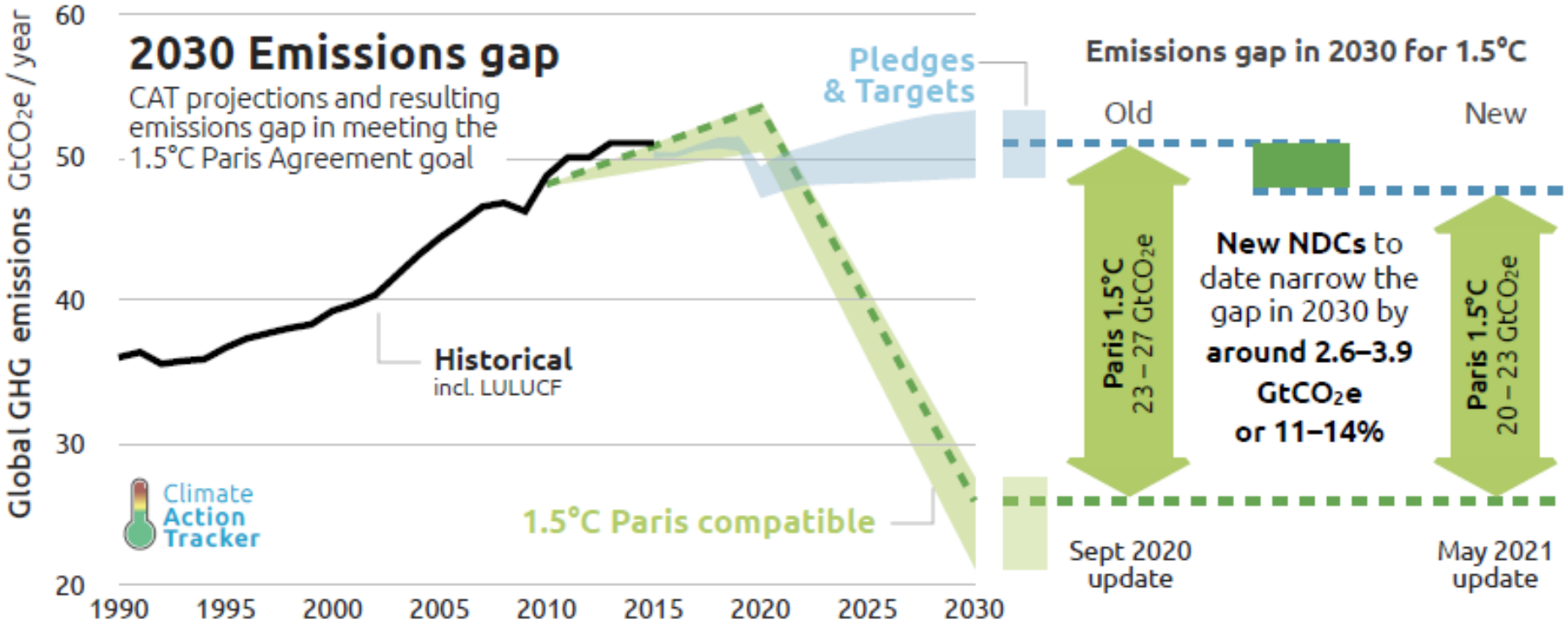
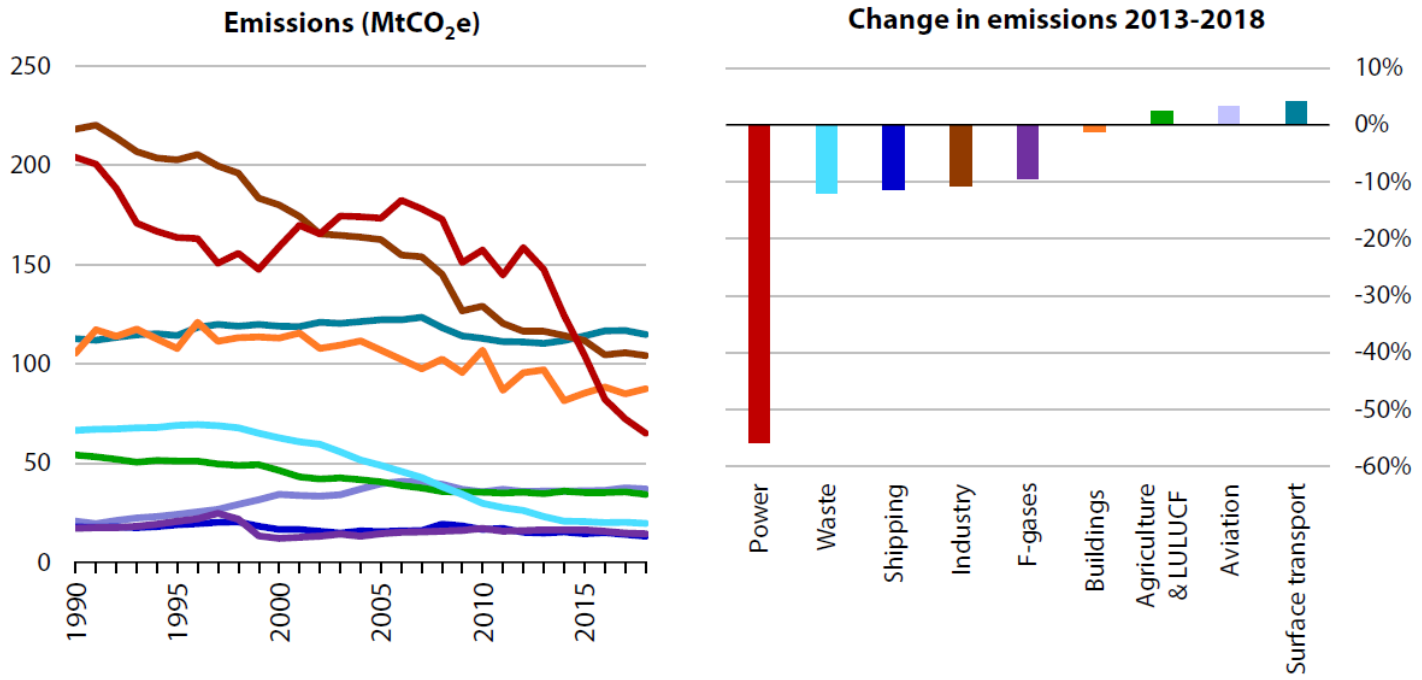


Figure 1.5. Trends in UK sectoral GHG emissions

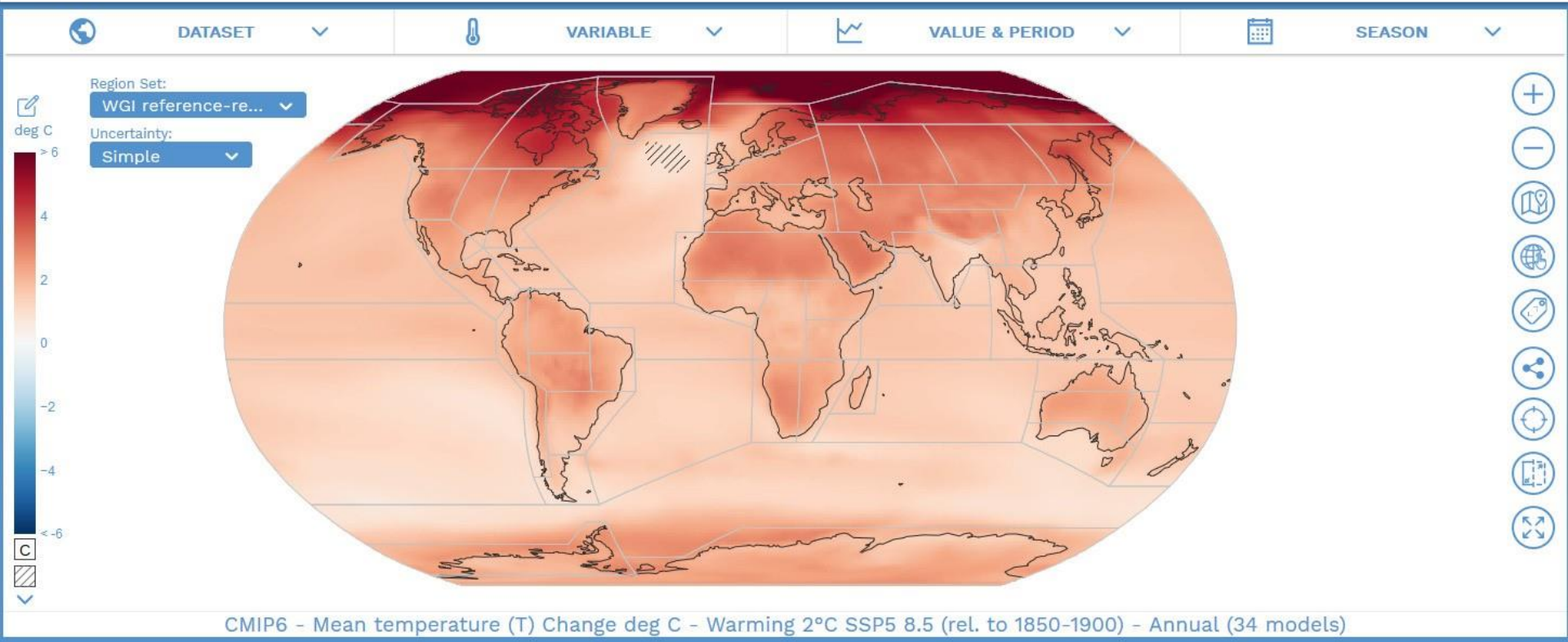


Source: BEIS (2019) *2018 UK Greenhouse Gas Emissions, Provisional Figures*; BEIS (2019) *2017 UK Greenhouse Gas Emissions, Final Figures*; CCC calculations.

Notes: The chart on the right-hand side shows changes in sectoral emissions between 2013 and 2018 for all sectors except for Agriculture, LULUCF, Waste and F-Gases which cover the period 2013-2017; buildings emissions in this chart are temperature-adjusted.

Interactive Atlas

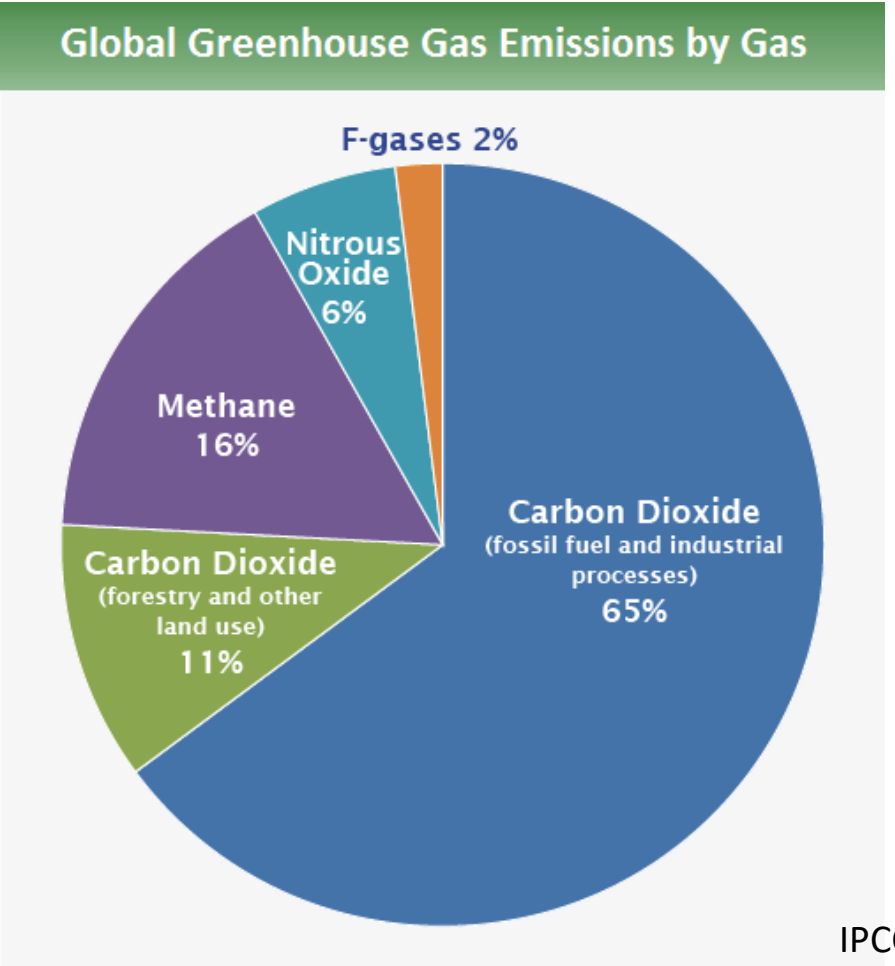
interactive-atlas.ipcc.ch

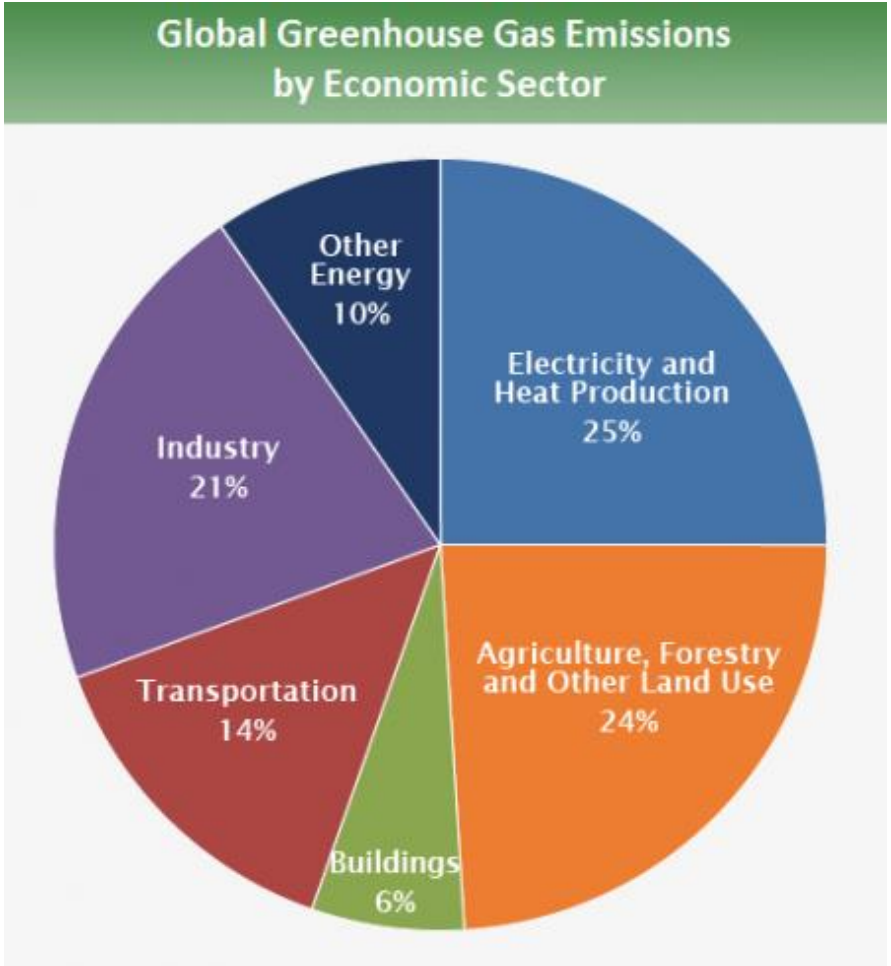


9 things you can do about climate change

https://www.imperial.ac.uk/grantham/

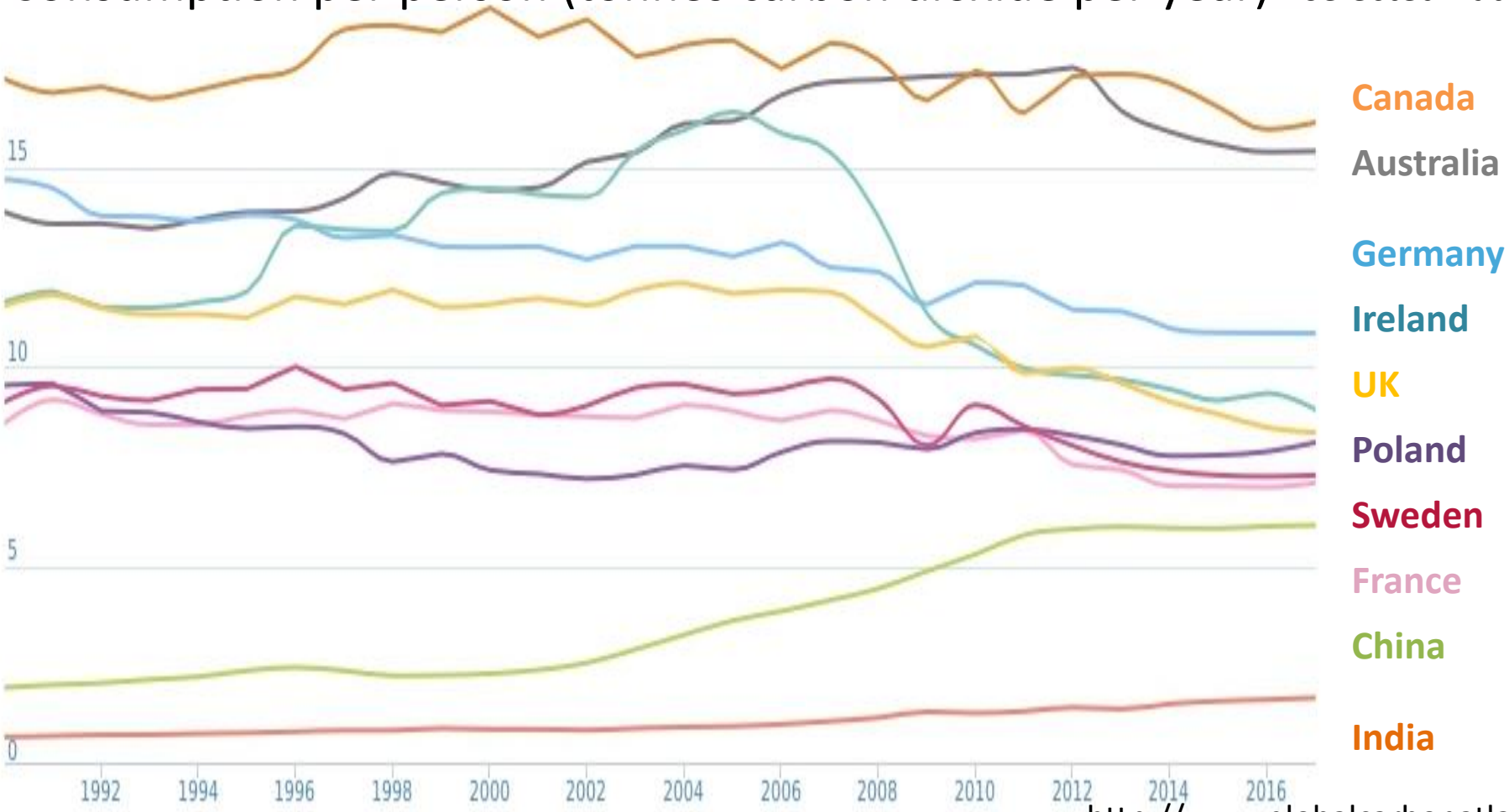
Global GHG emissions





IPCC 2014

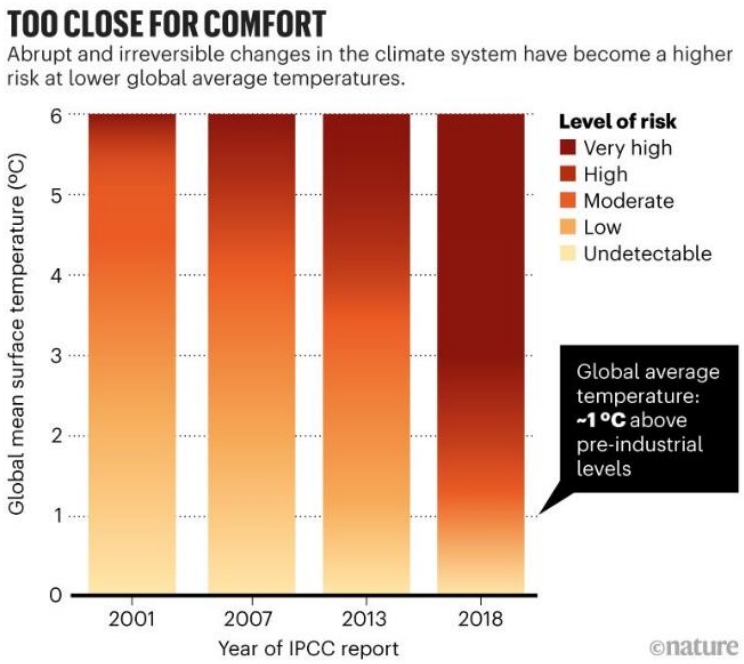
Consumption per person (tonnes carbon dioxide per year) - selected nations



http://www.globalcarbonatlas.org/

Tipping points

Assessment of risk:



Source: IPCC

Hypothesised links:

Lenton et al (2019)

Observed changes in heavy precipitation

Type of observed change
in heavy precipitation

- Increase (19)
- Decrease (0)
- Low agreement in the type of change (8)
- Limited data and/or literature (18)

Confidence in human contribution
to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence

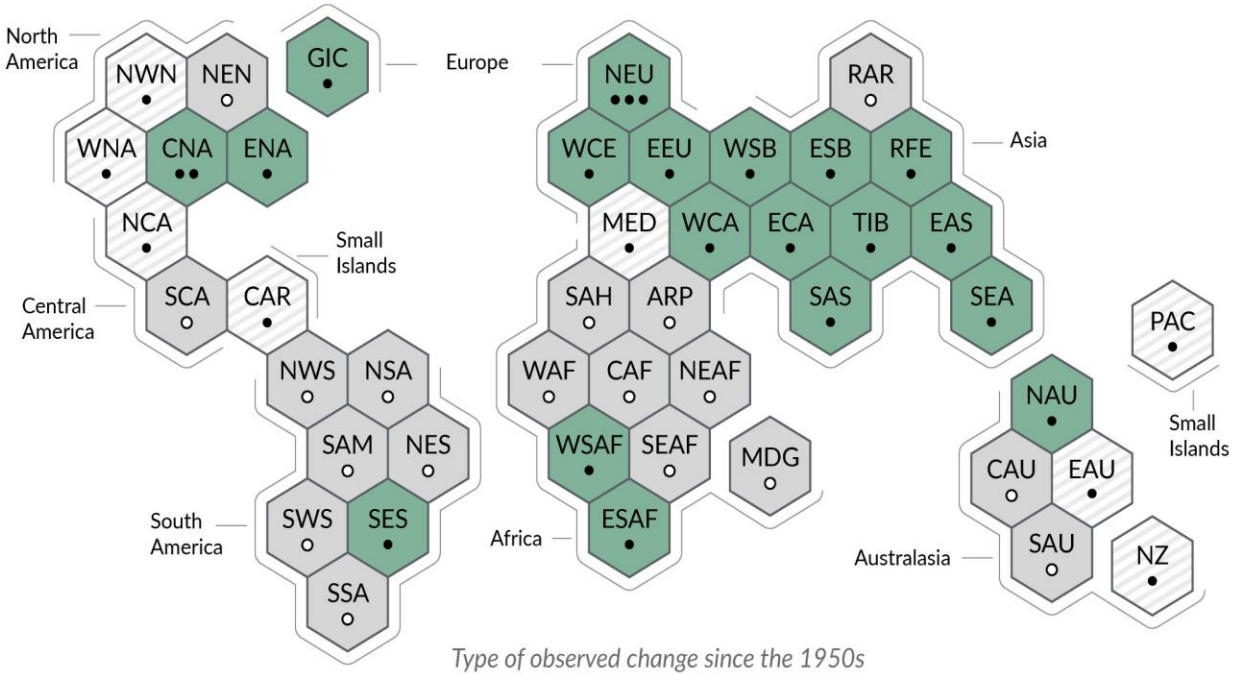


Figure SPM.3

Observed changes in agricultural and ecological drought

Type of observed change
in agricultural and ecological drought

- Increase (12)
- Decrease (1)
- Low agreement in the type of change (28)
- Limited data and/or literature (4)

Confidence in human contribution
to the observed change

- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence

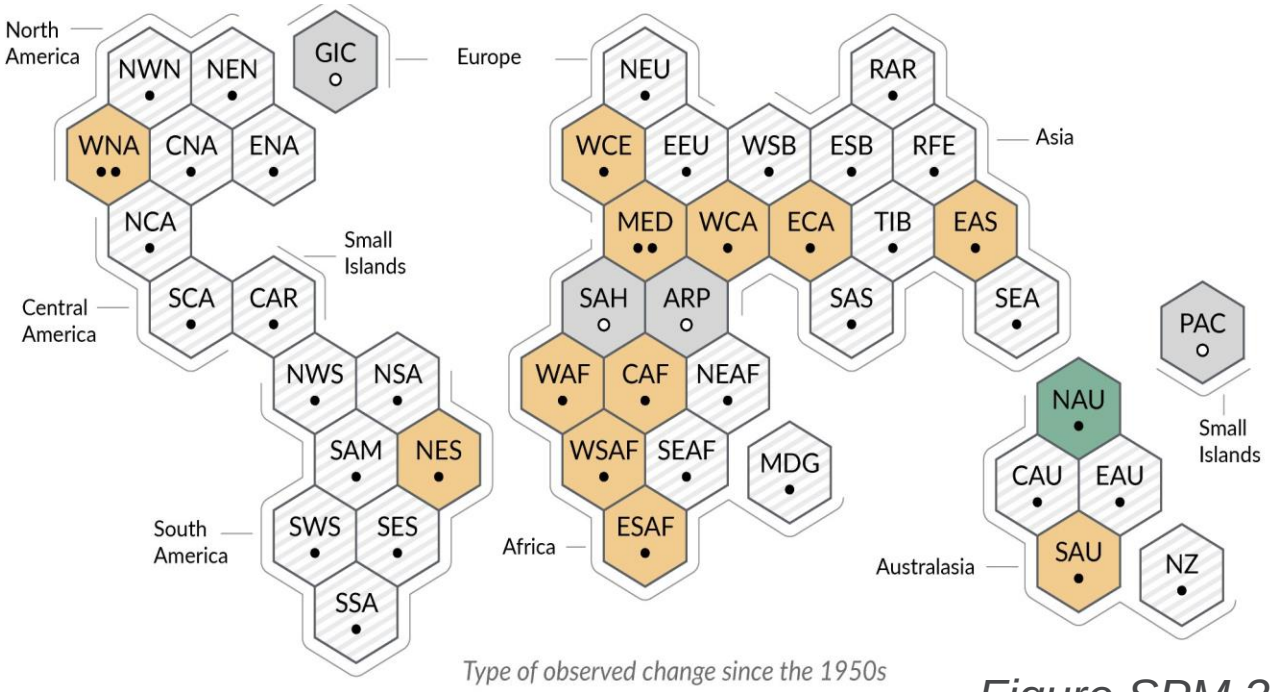
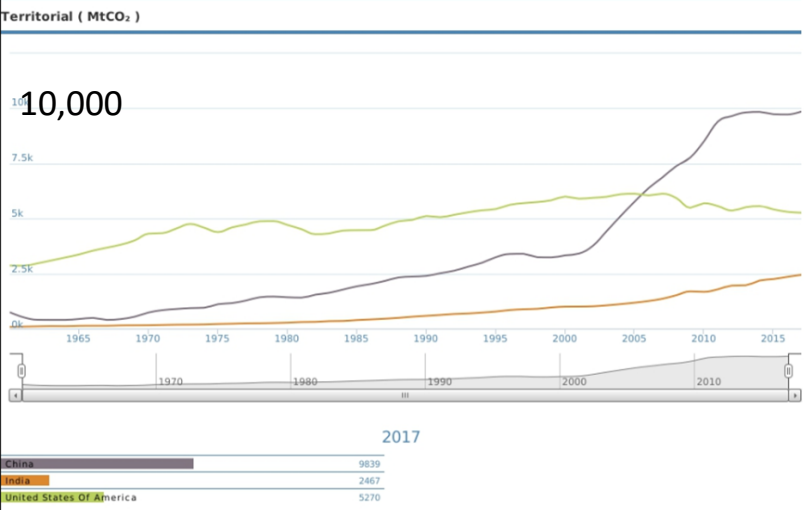
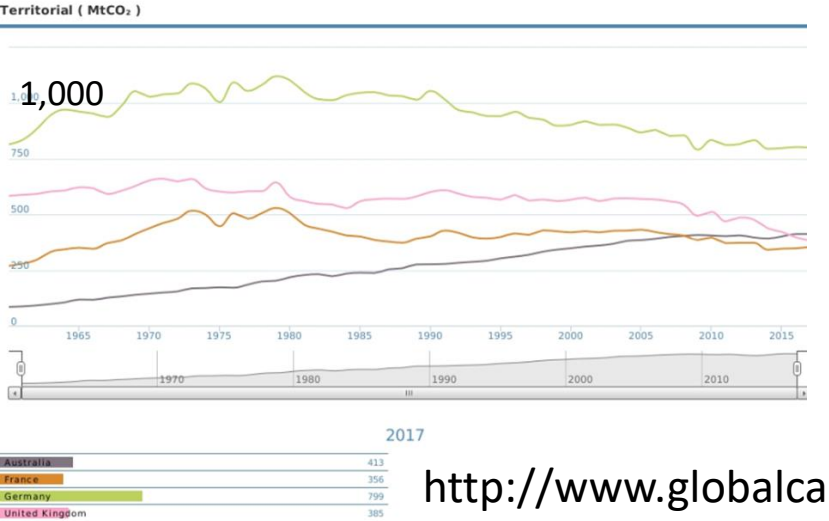
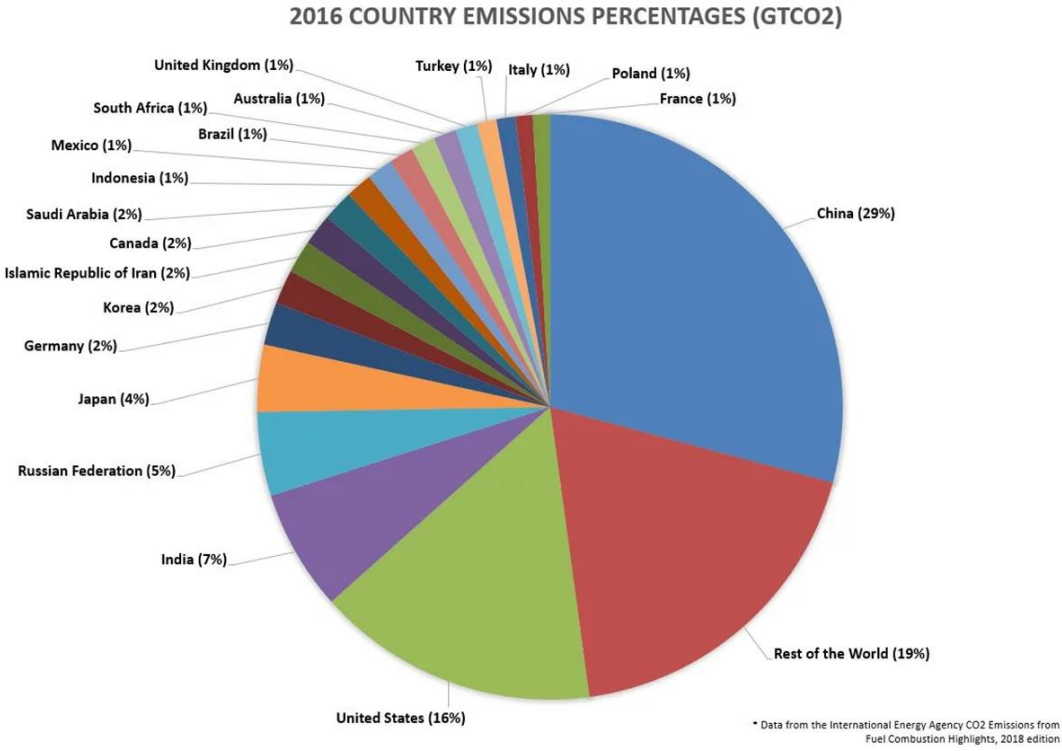


Figure SPM.3

Emissions by country







http://www.globalcarbonatlas.org

Committee on Climate Change Net Zero report May 2019

https://www.theccc.org.uk/

- UK net zero greenhouse gases by 2050.
- Further decarbonisation of electricity.
- Electrification of transport.
- Buildings: insulation, heat pumps.
- Hydrogen for power, heat, in gas grid, HGVs?
- Agricultural emissions: livestock breeding, waste management.
- CCS, tree-planting....

Intergovernmental Panel on Climate Change (IPCC)

1988 IPCC set up by the World Meteorological Organization and the United Nations Environment Programme to assess the state of the climate

1992 United Nations Framework Convention on Climate Change (UNFCCC)

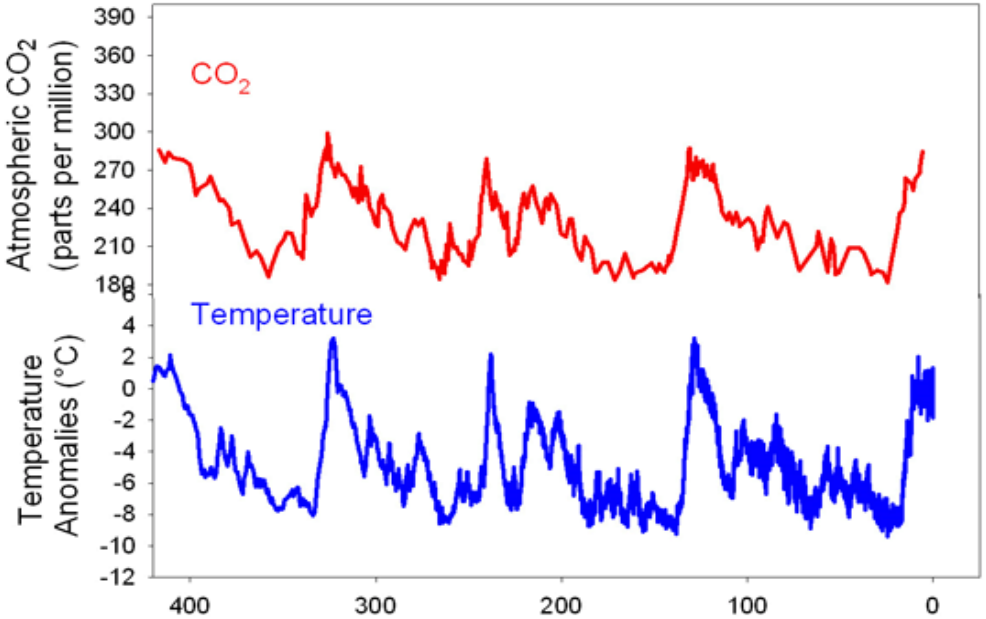
Annual Conference of the Parties (to UNFCCC) since 1995:
COP1 Berlin
COP3 1997 Kyoto Protocol
COP15 2009 Copenhagen
COP21 2015 Paris
COP26 2021 Glasgow

https://www.ipcc.ch/

IPCC reports

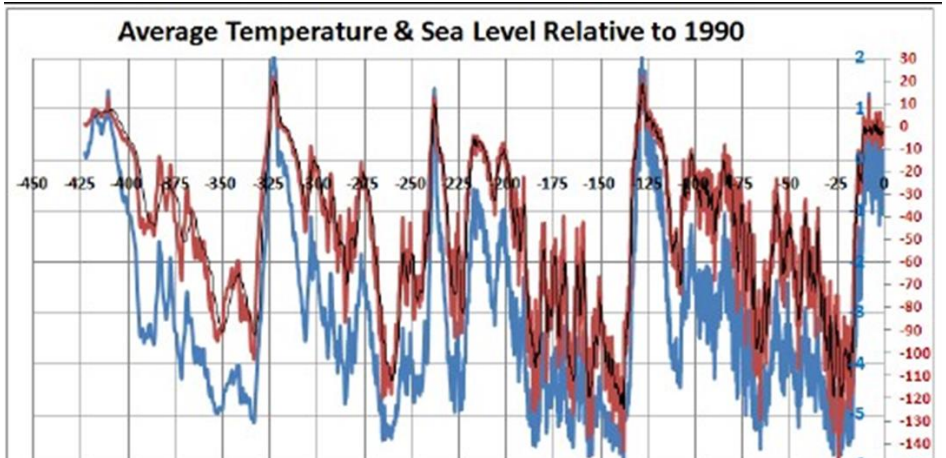
- Major assessment reports 1990, 1996, 2001, 2007, 2014, (2021)
- Other special reports (e.g. oceans & cryosphere 2019)
- International teams of hundreds of authors from all UN countries reviewing the state of climate science from peer-reviewed papers.
- IPCC does not “do” science
- Multiple drafts and rounds of reviewing
- Precise definitions of confidence e.g. “likely”
- Wording – especially of summaries – very carefully constructed

Sea level & ice melt



~100 ppm

~7°C



Temperature

Sea Level

~120 m