Department of Meteorology

University of Reading

The Physical Science Basis for Climate Change: Causes & Consequences

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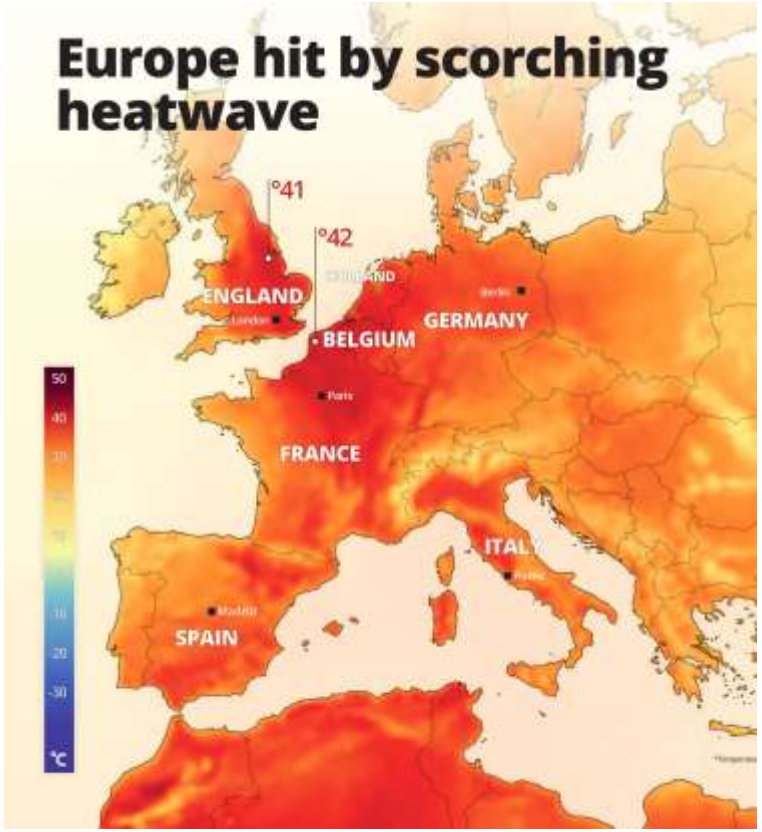
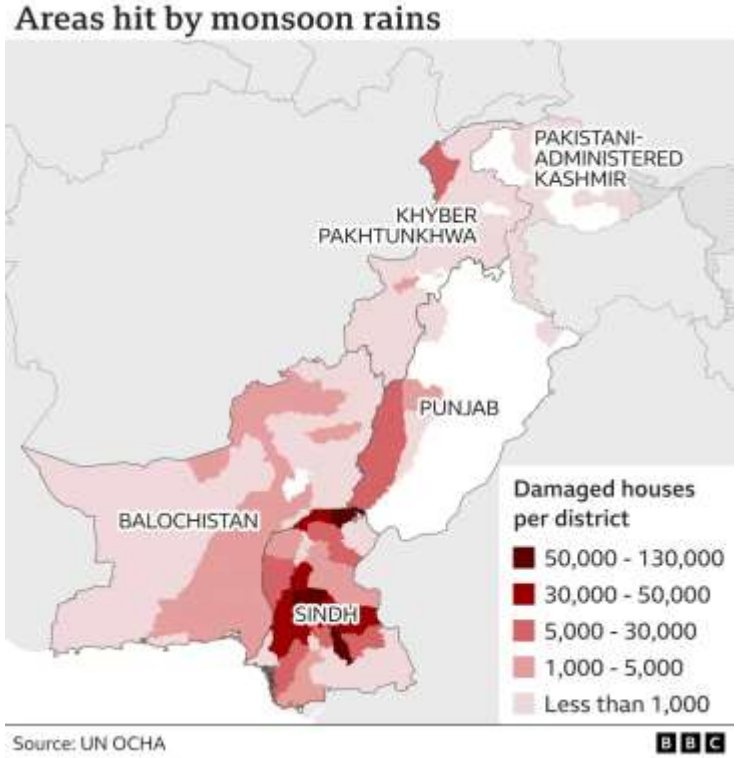
National Centre for Earth Observation
NATURAL ENVIRONMENT RESEARCH COUNCIL

Ongoing Climate Change





www.met.reading.ac.uk/~sgs02rpa/extreme.html

Climate change over last 800,000 years

418 ppm

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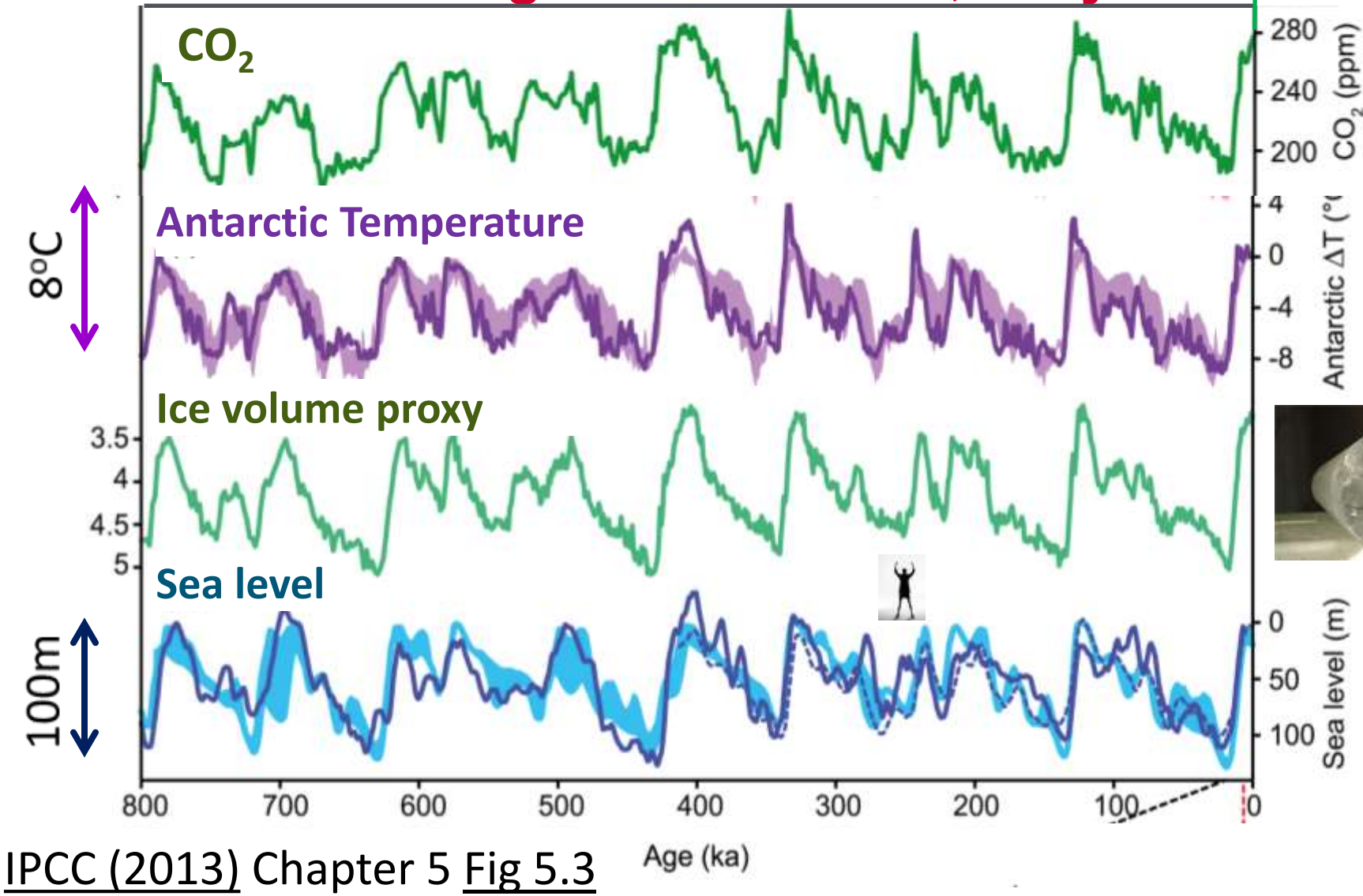
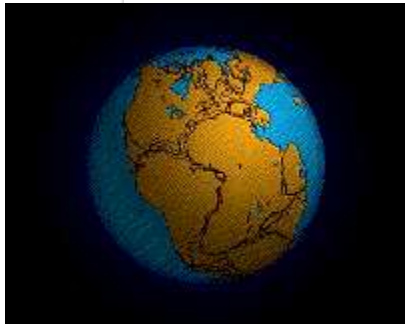
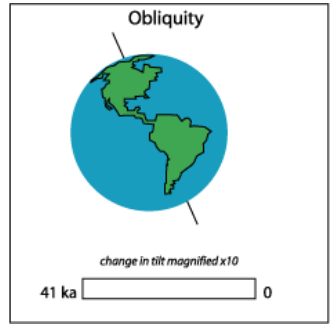


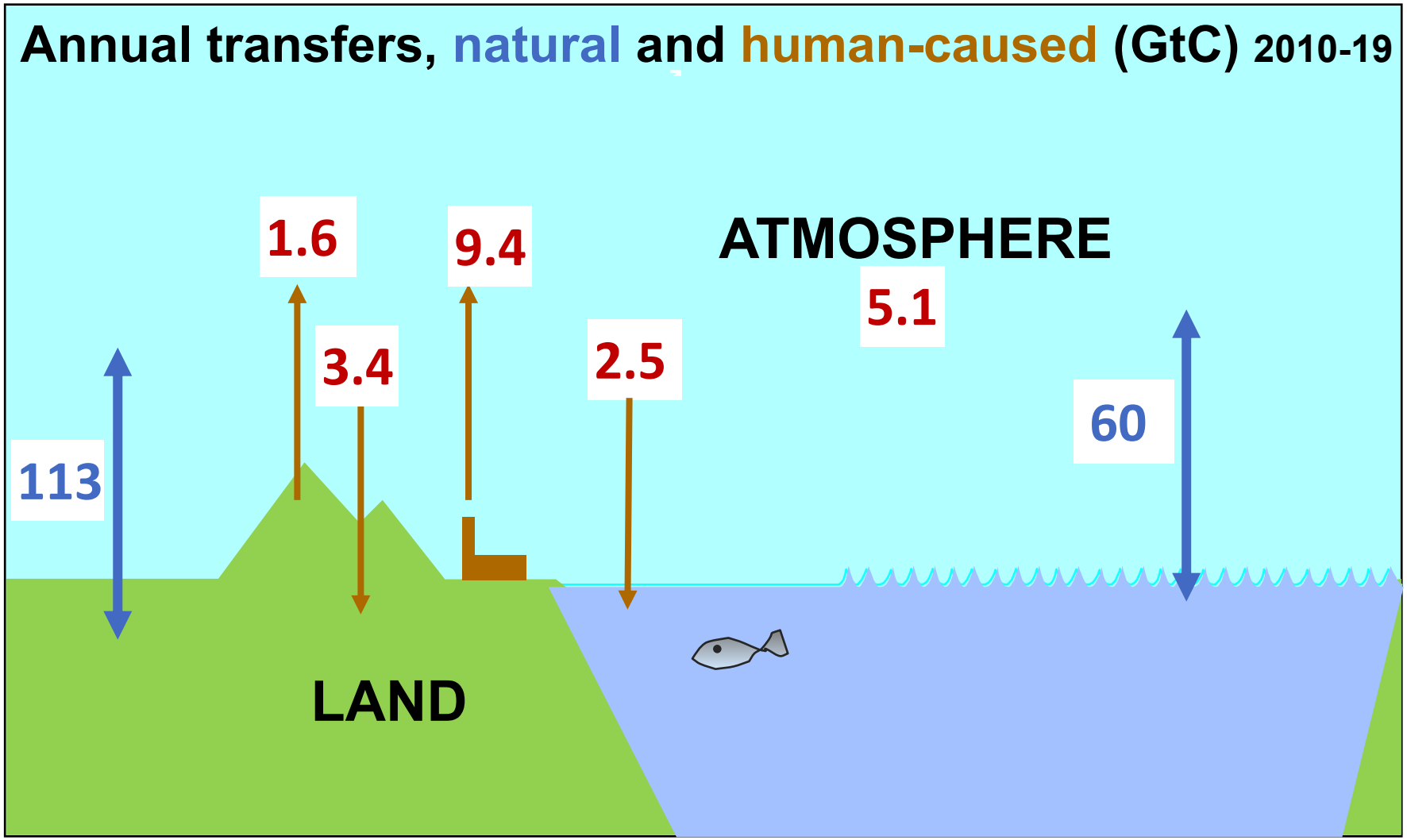
IPCC (2013) Chapter 5 Fig 5.3

The climate has always changed. But…





Natural & human-influenced carbon cycle



- Human activities have tipped the natural carbon cycle out of balance
- This is driving increases in atmospheric CO_2 concentrations
- CO_2 concentrations highest in at least 2 million years

Values in billions of tonnes of Carbon per year from IPCC (2021) Ch5

It is indisputable that human activities are causing climate change

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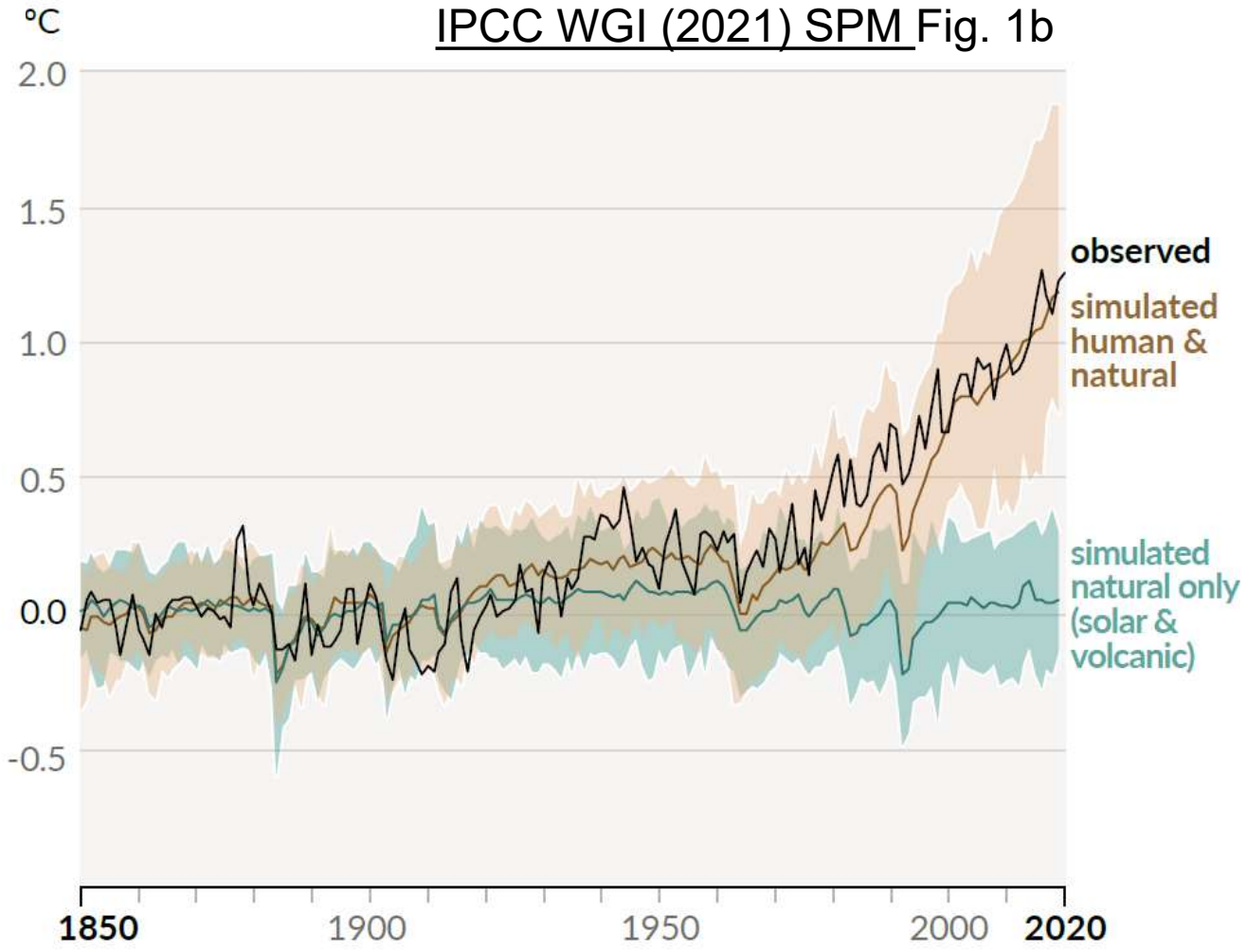
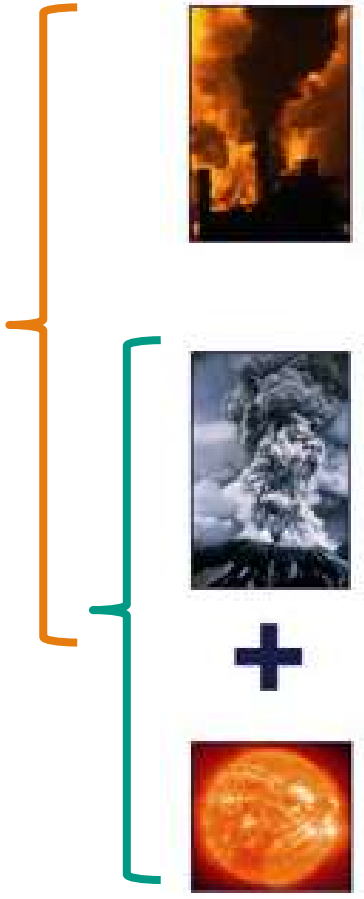
IPCC WGI (2021) SPM Fig. 1b





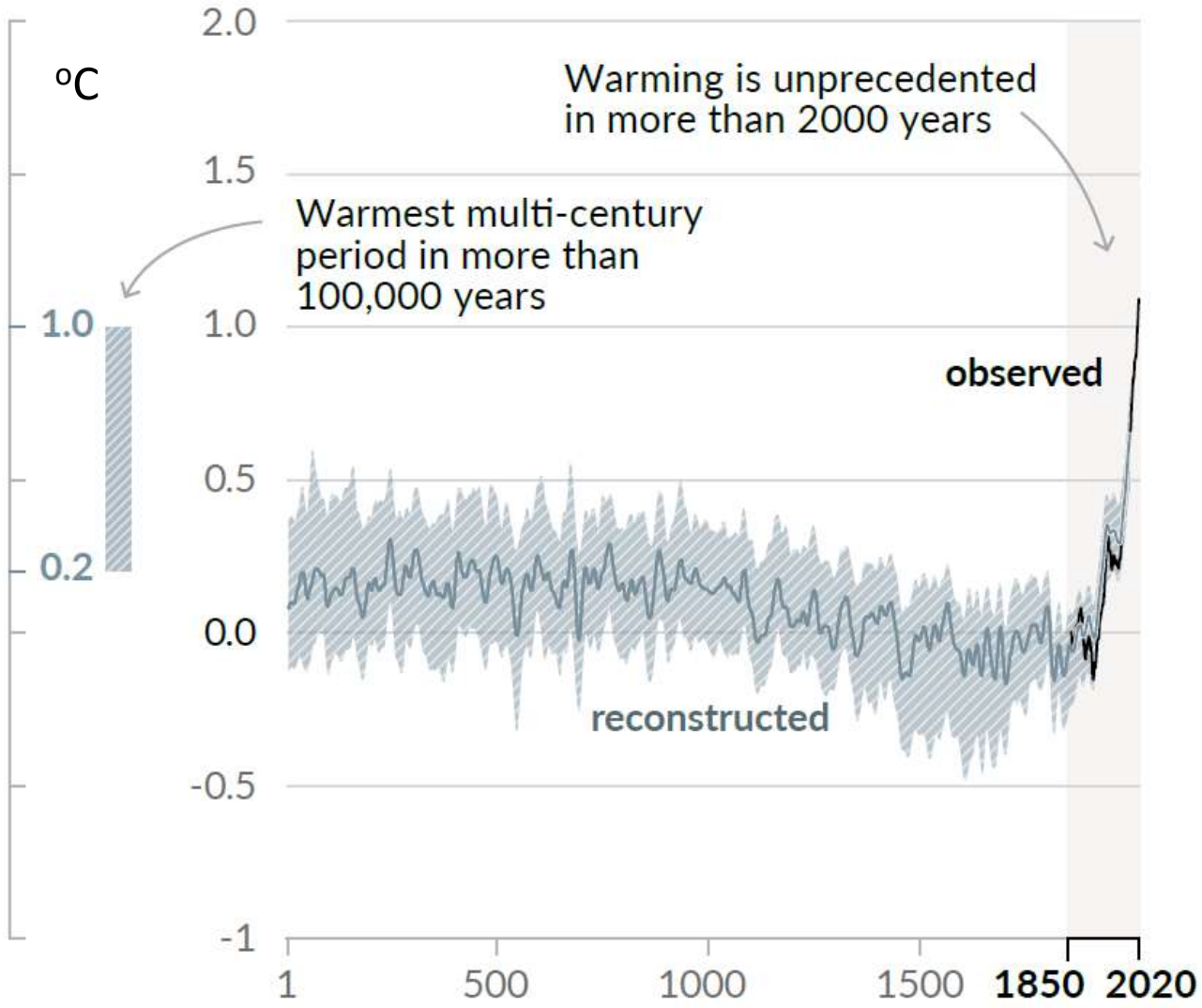
► Observed warming is driven by emissions from human activities

► Greenhouse gas warming has been partly masked by aerosol cooling

► Warming is amplified by feedback loops involving water vapour, ice & clouds

► Natural factors do not contribute to rapid warming over past 5 decades

Recent changes in the climate are widespread, rapid and unprecedented in thousands of years



- Global mean surface temperature increased faster since 1970 than in any other 50 year period over at least the last 2000 years
- Warmth of past decade comparable to last interglacial 125,000 years ago *[when peak sea level was 5-10m higher than today]*

[IPCC WGI 2021 SPM]

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

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Figure SPM.3

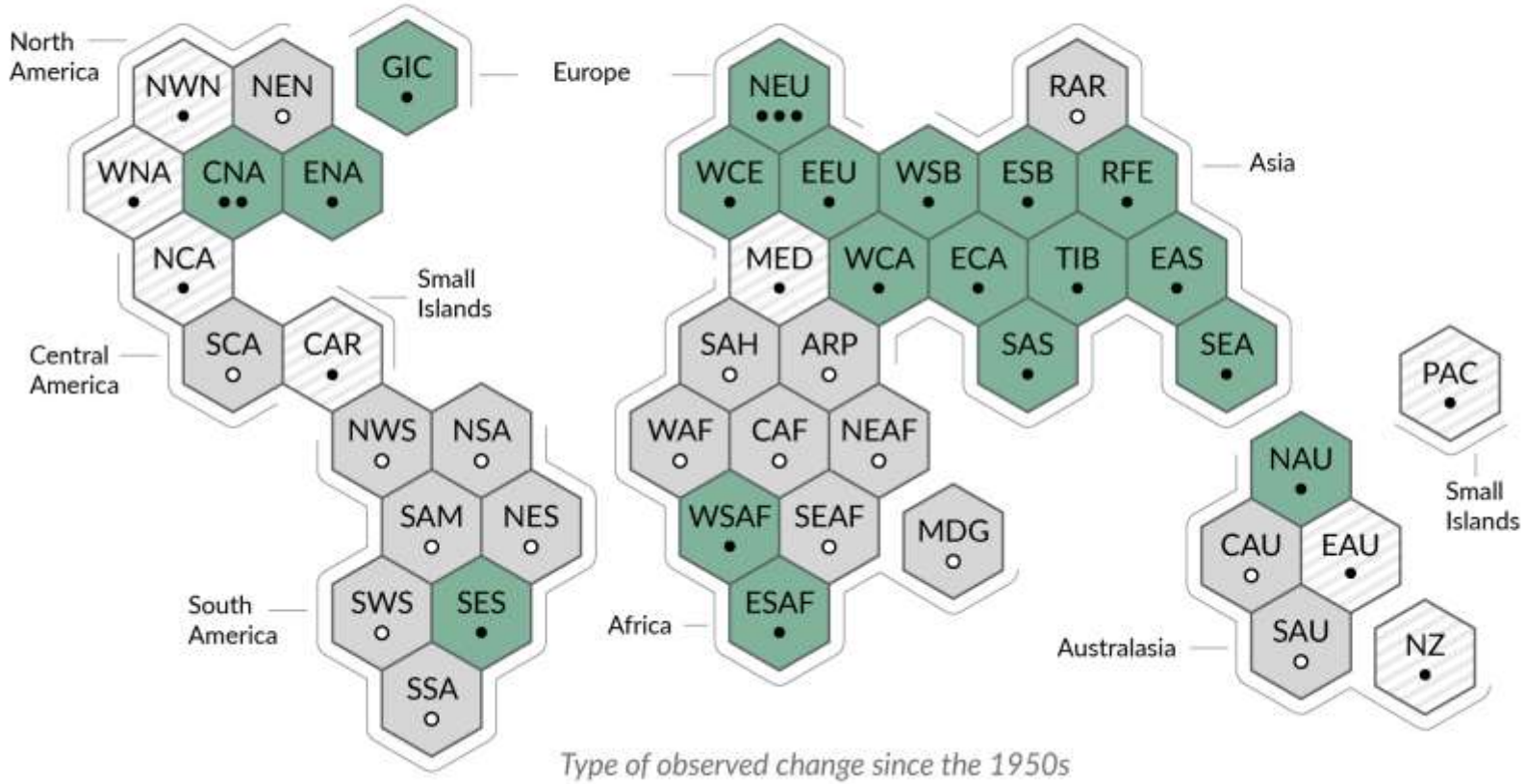
b) Synthesis of assessment of observed change in **heavy precipitation** and confidence in human contribution to the observed changes in the world's regions

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



Type of observed change since the 1950s

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

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Figure SPM.3

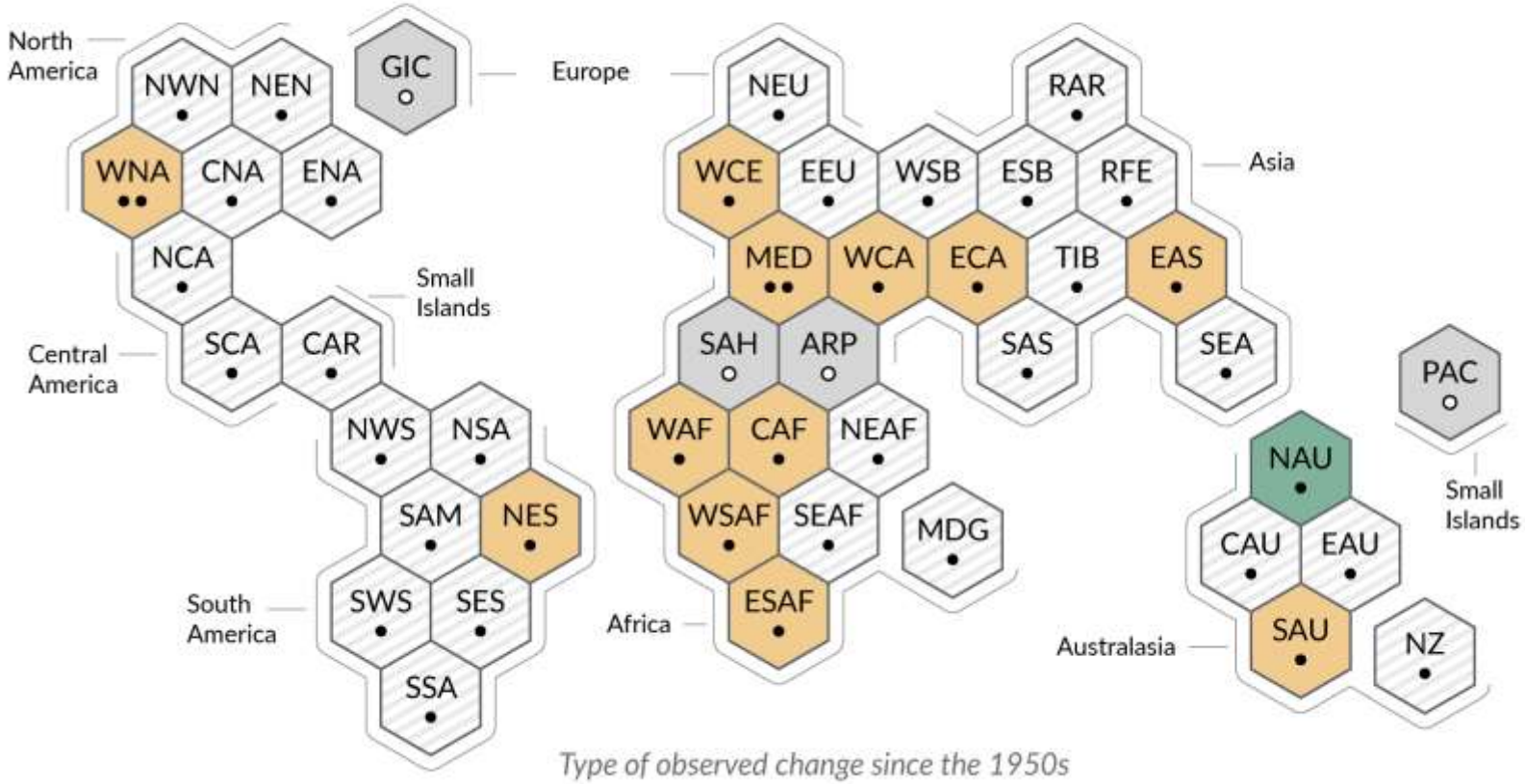
c) Synthesis of assessment of observed change in **agricultural and ecological drought** and confidence in human contribution to the observed changes in the world's regions

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

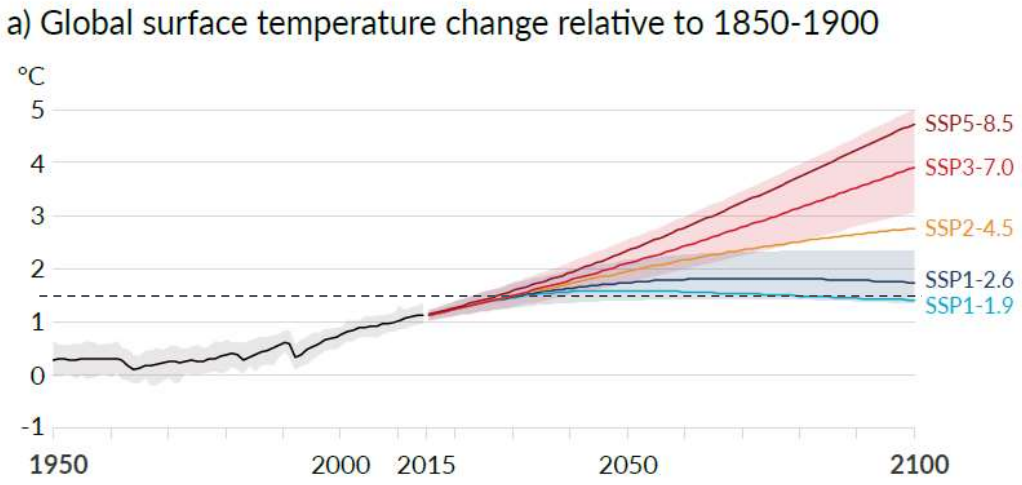
- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence



Type of observed change since the 1950s

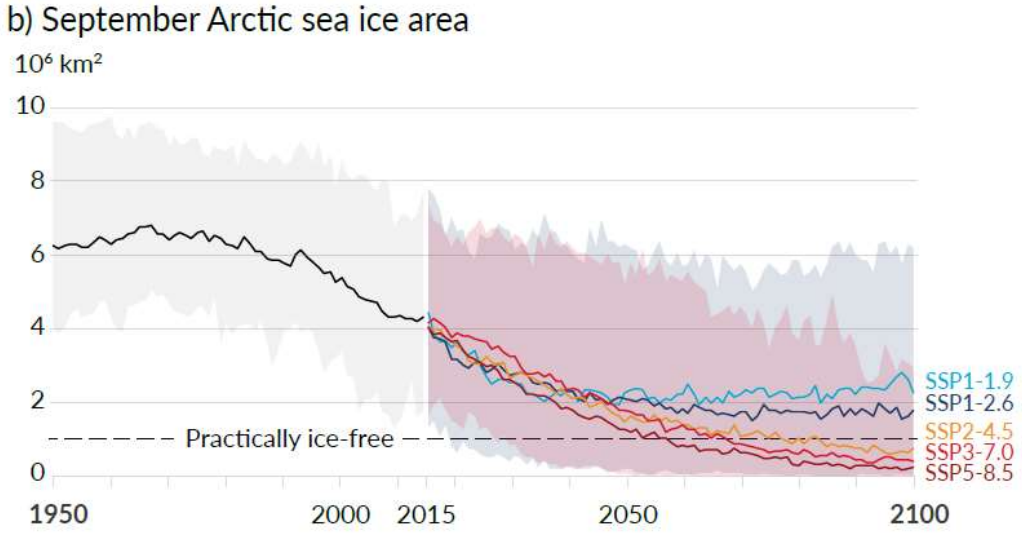
> Continued global warming is projected to further intensify the global water cycle, including its variability, global monsoon precipitation and the severity of wet and dry events.

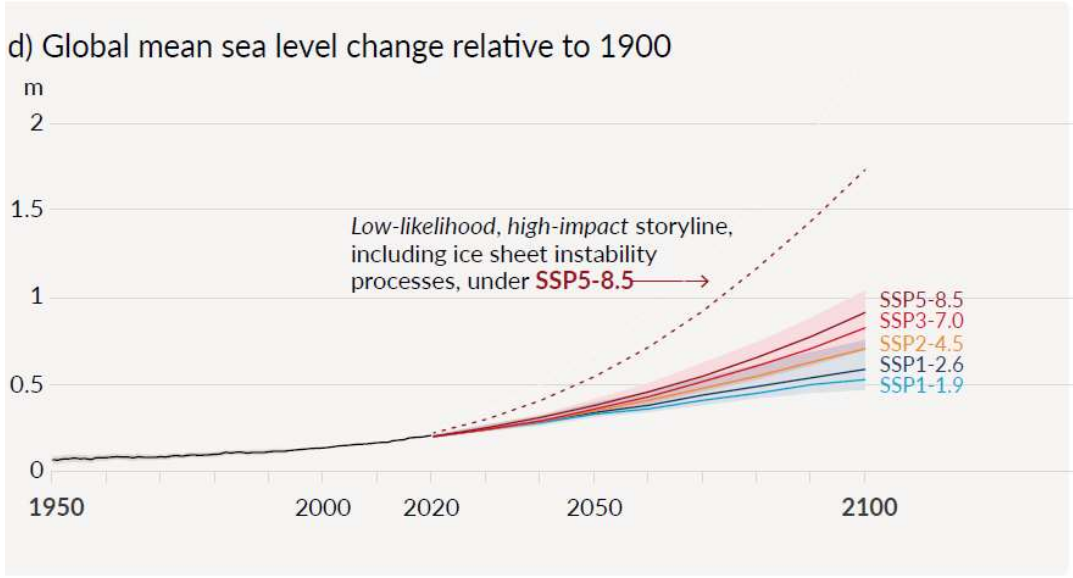
Some changes in the climate system are irreversible but many changes can be slowed or stopped by limiting warming

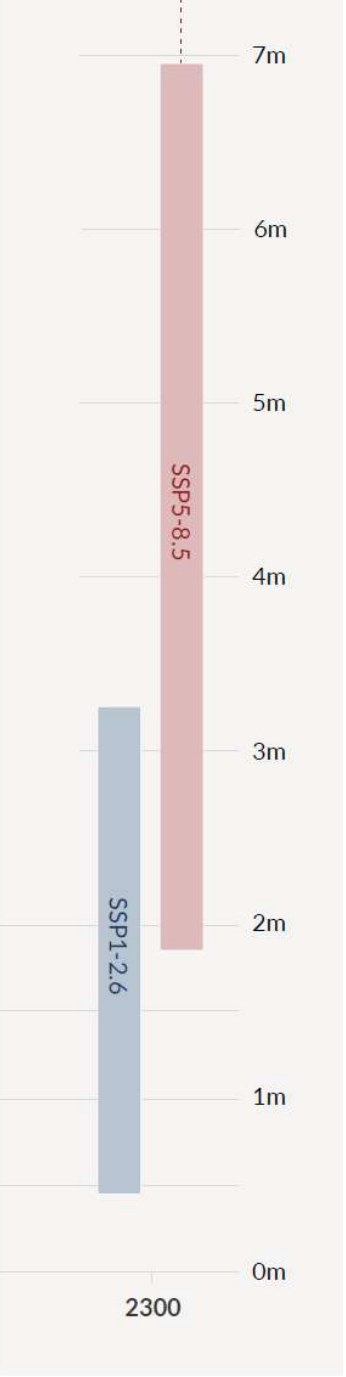


Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in CO_2 and other greenhouse gas emissions occur in the coming decades
[IPCC (2021) WG1 SPM]

High emissions
Low emissions







Solution: Cut CO_2 Emissions to Net Zero

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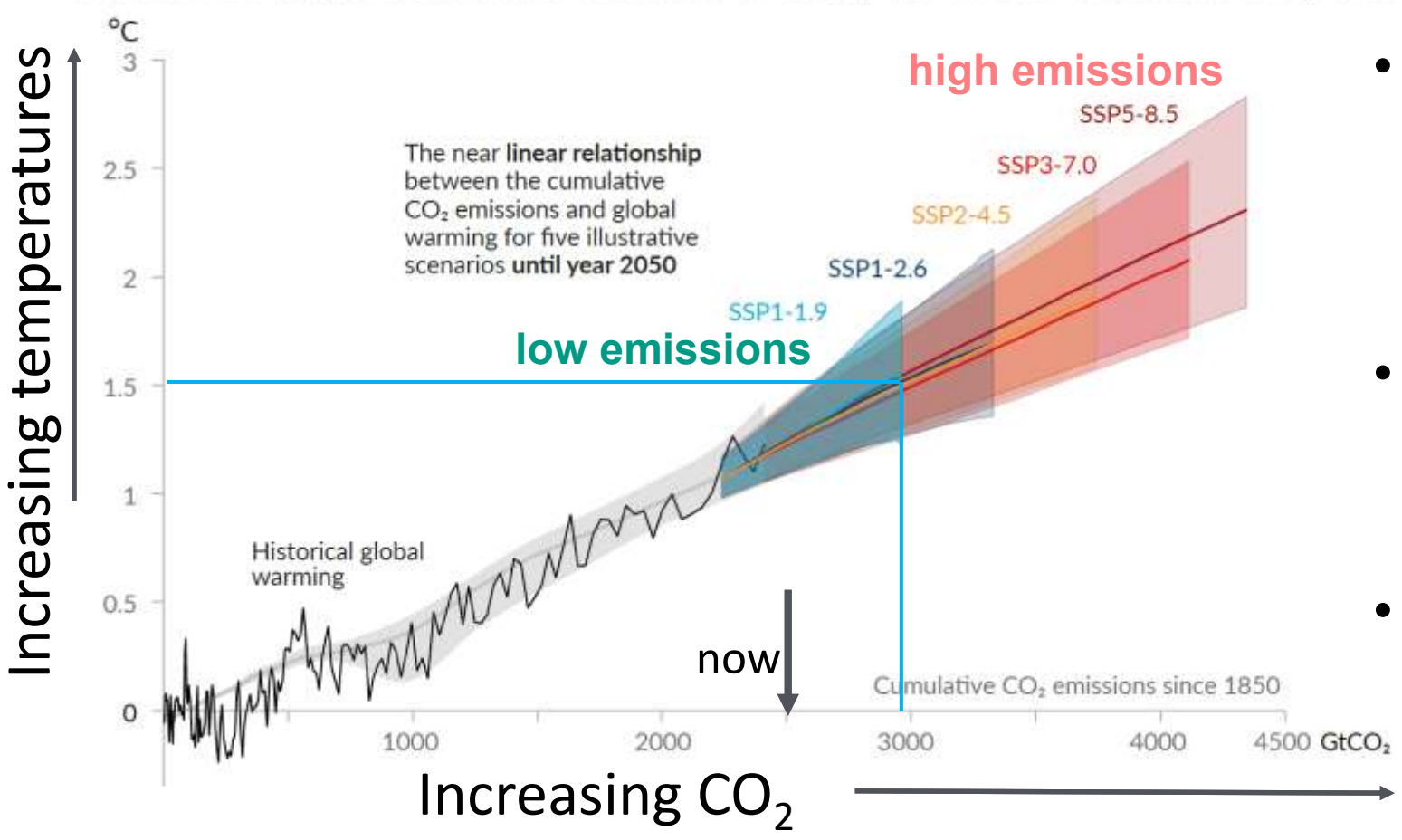


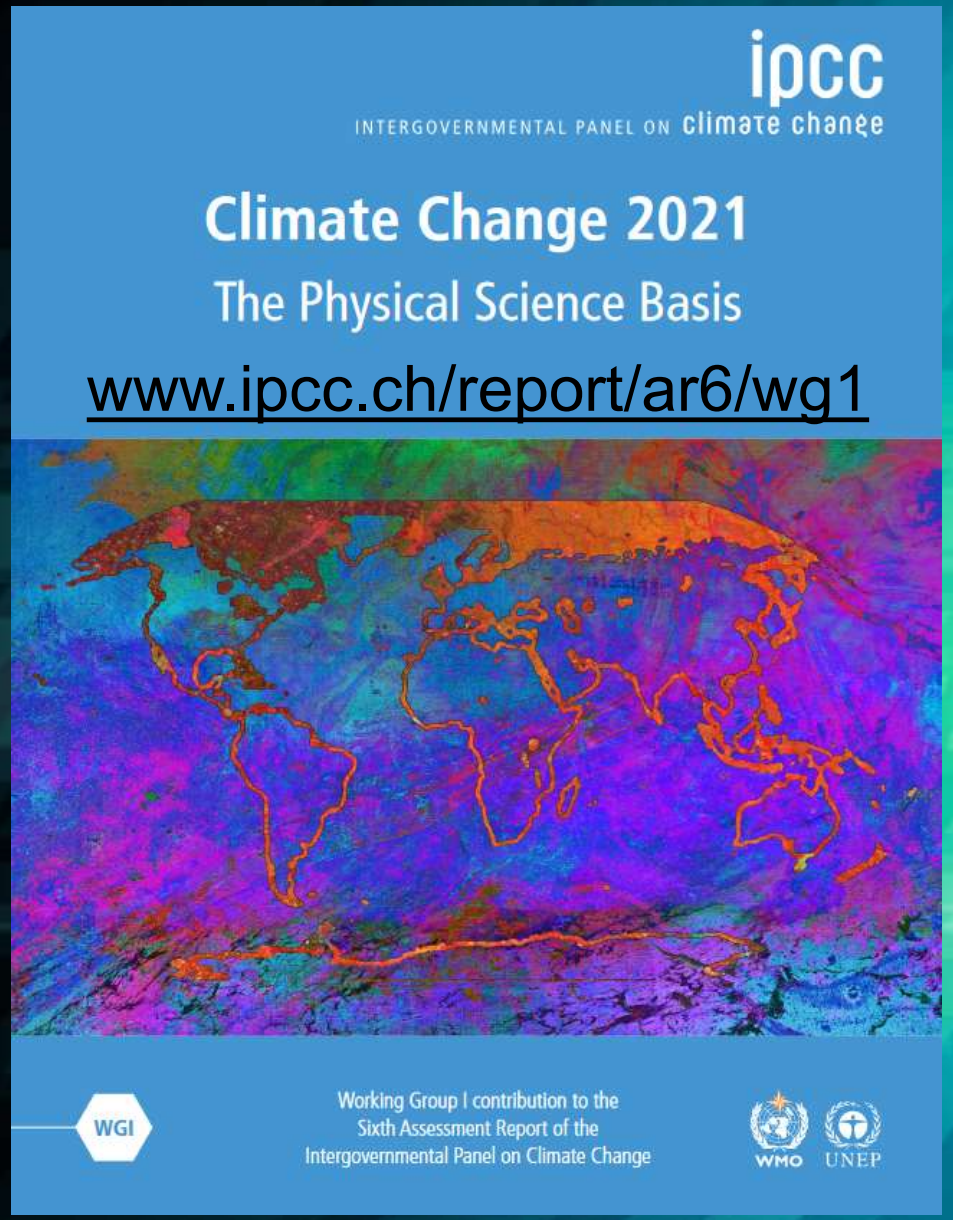
- Each 1000 billion tonnes of CO_2 emission increases global temperature by 0.5°C
- It is still physically possible to limit global warming to 1.5°C
- Deep cuts in CO_2 and other greenhouse gas emissions essential in coming decades

[IPCC WGI 2021 SPM]

Summary

- Earth's climate has always varied but it is an established fact that human activities are now driving climate change
- Recent changes in climate are widespread, rapid and unprecedented in thousands of years.
- Human activities are intensifying extreme climate events, including heat waves, heavy rainfall, and droughts
- Every bit of global warming increases the magnitude of regional climate change including the severity of extremes
- It is possible to limiting warming to 1.5°C with immediate, rapid, and large-scale reductions in greenhouse gas emissions

IPCC report: www.ipcc.ch/assessment-report/ar6/



IPCC (2023) Synthesis Report published Monday 20th March

Digital emissions & solutions

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- **Digital technologies** impact positively & negatively greenhouse gas emissions e.g. their own carbon footprint & induced larger social change… broader sustainability concerns due to use of rare materials, associated waste, potential negative impact on inequalities (Chapter 16, Cross-Chapter Box 11)
- Digital technology and **digitalisation** can enable emission reductions, but can have adverse side effects unless appropriately governed and can involve trade-offs e.g. increasing **electronic waste**.
- Improved **energy management** in all sectors can increase energy efficiency… **Growth in demand** for goods & services due to use of digital devices could reduce or counterbalance mitigation gains [WG3 Summary for Policy Makers]
- Role of smart apps & **disruptive technologies** at the demand and supply side on GHG emissions needs to be better understood (Chapter 2, Section 2.9)