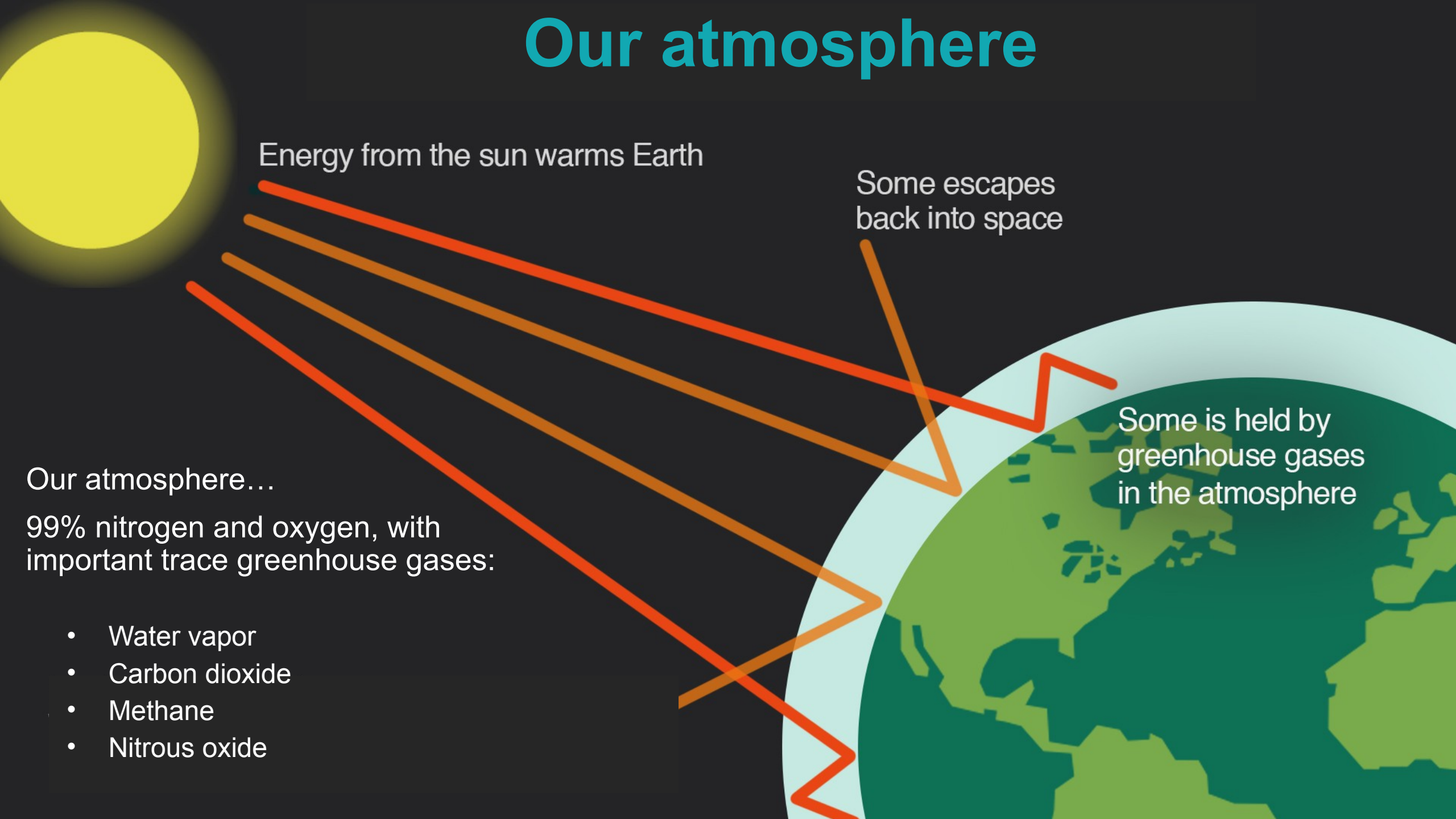


Climate Change – The science bit

What we know

Our atmosphere



Energy from the sun warms Earth

Some escapes
back into space

Some is held by
greenhouse gases
in the atmosphere

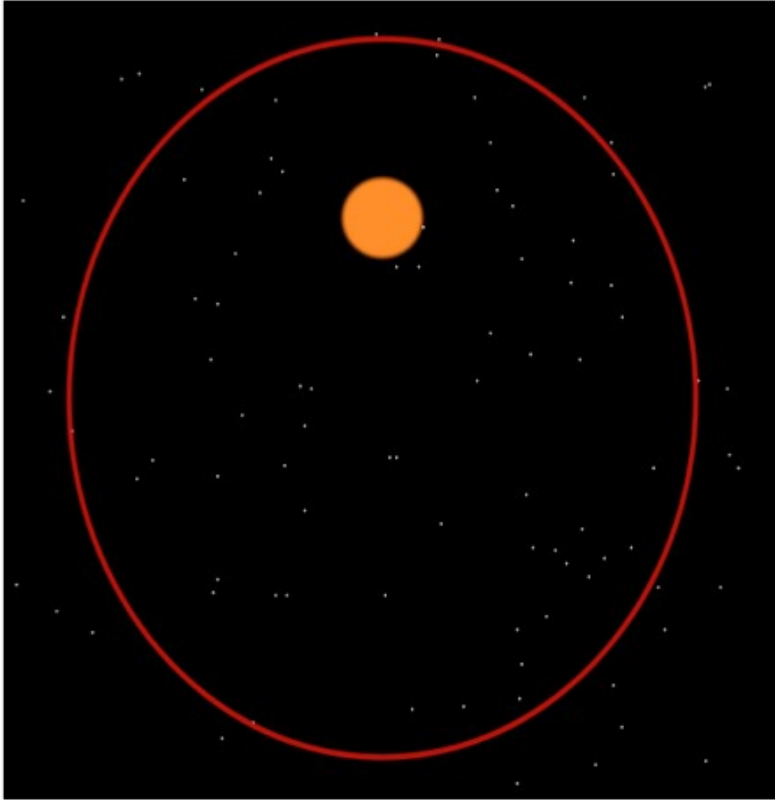
Our atmosphere...

99% nitrogen and oxygen, with
important trace greenhouse gases:

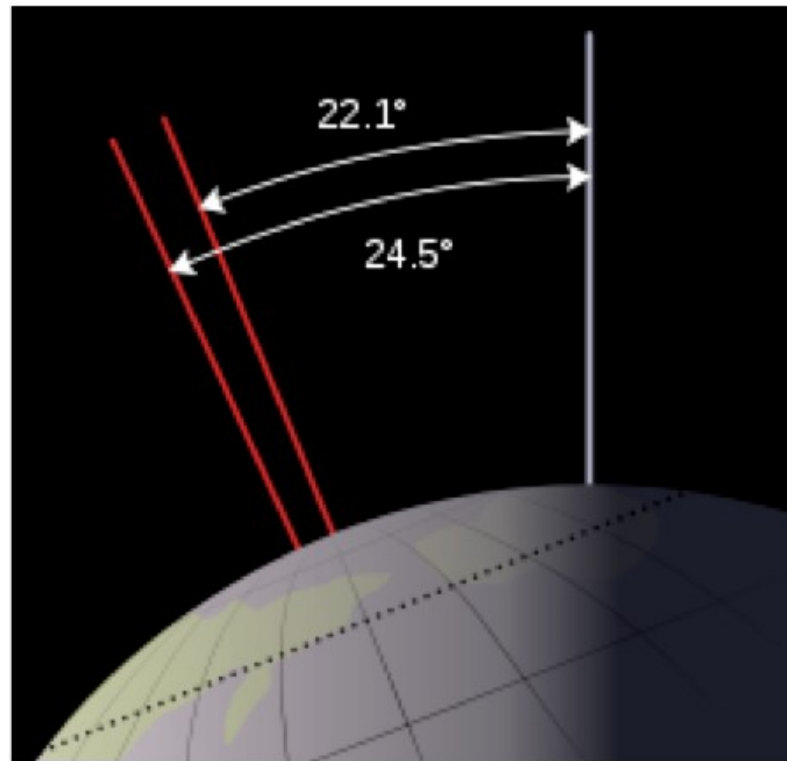
- Water vapor
- Carbon dioxide
- Methane
- Nitrous oxide

A wobbly world

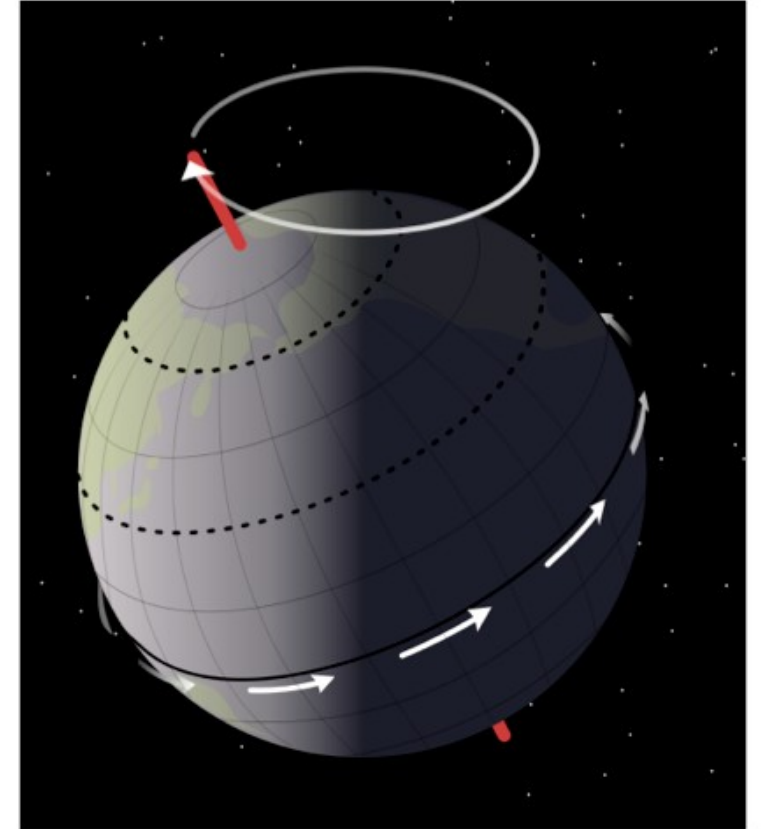
- The Earth's orbit and tilt changes due to orbital dynamics (known as "Milankovitch Cycles"; identified in the 1920s)



Eccentricity
~100 kyr



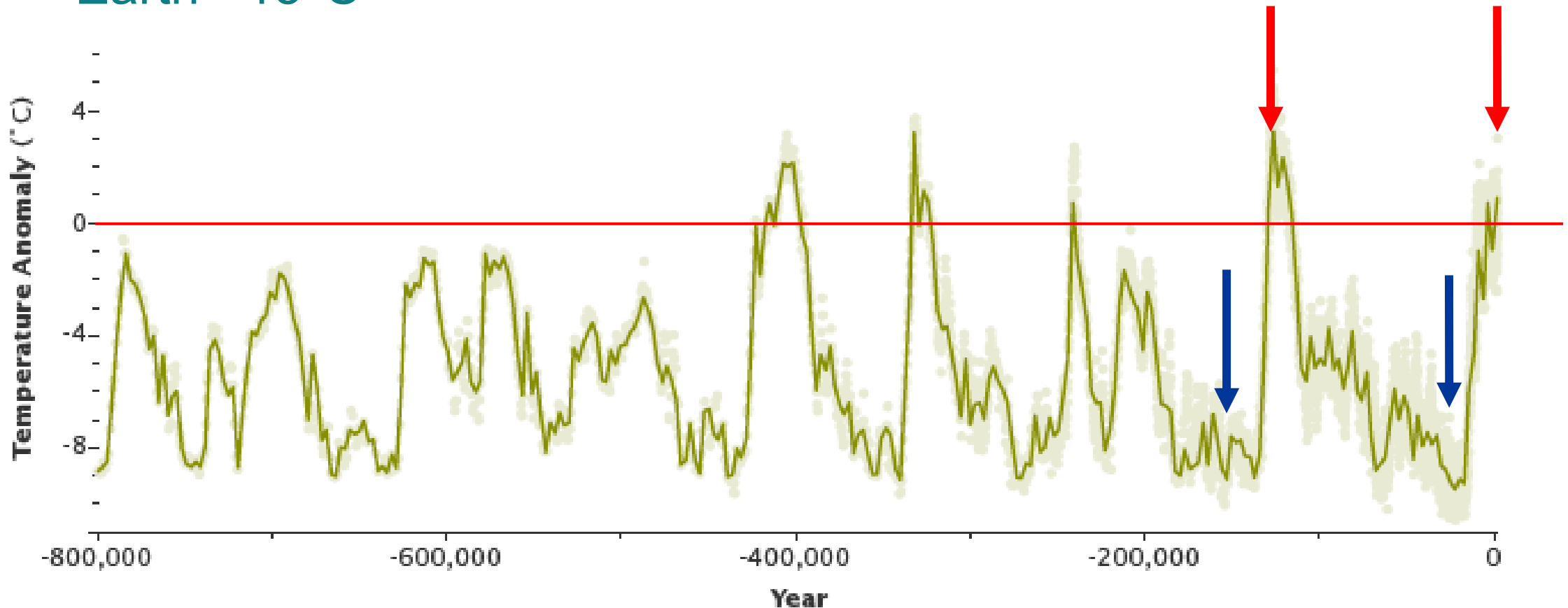
Obliquity (tilt)
~41 kyr



Precession
~22 kyr

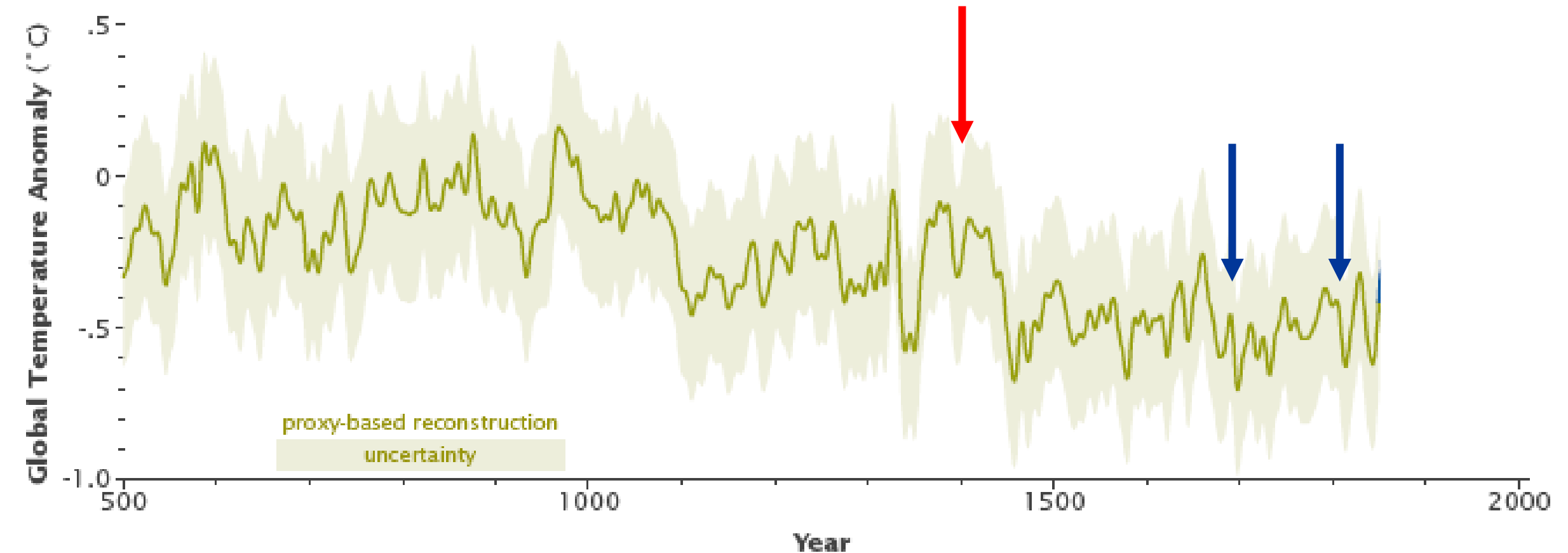
Climate Cycles

- The Earth has warmed and cooled primarily creating **ice ages** and **interstitial periods** (*rapid warming*) periods. We're now in an **interstitial period** with an average global temperature of the Earth $\sim 15^{\circ}\text{C}$



Let's zoom in

- Long term records use “proxies” such as air bubbles in ice, tree rings, stalactites
- Features such as the medieval warm period, little ice age and volcanoes
- Human civilization has evolved in a highly stable climate



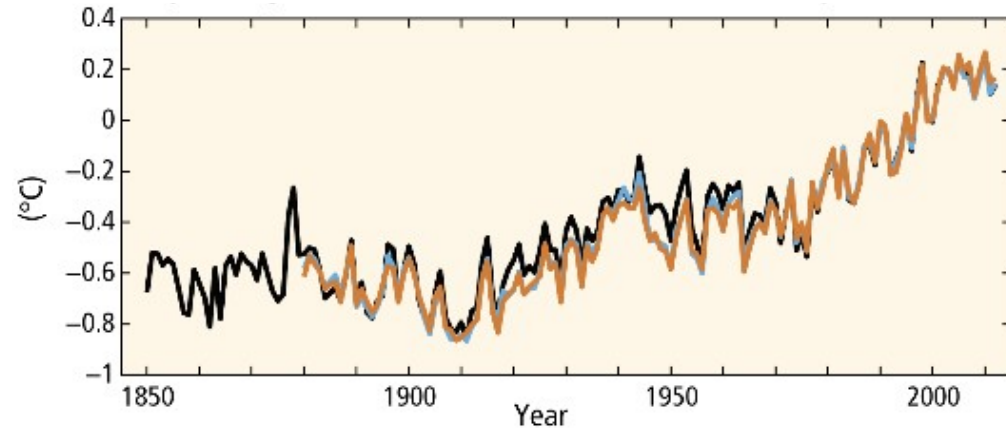
Greenhouse Gases

- Most common greenhouse gasses are inert
- Some specific low concentration gases trap heat (CO₂, O₃, N₂O, CH₄, H₂O)
- Greenhouse gases, mainly CO₂, warm the Earth by trapping heat that would otherwise escape to space.

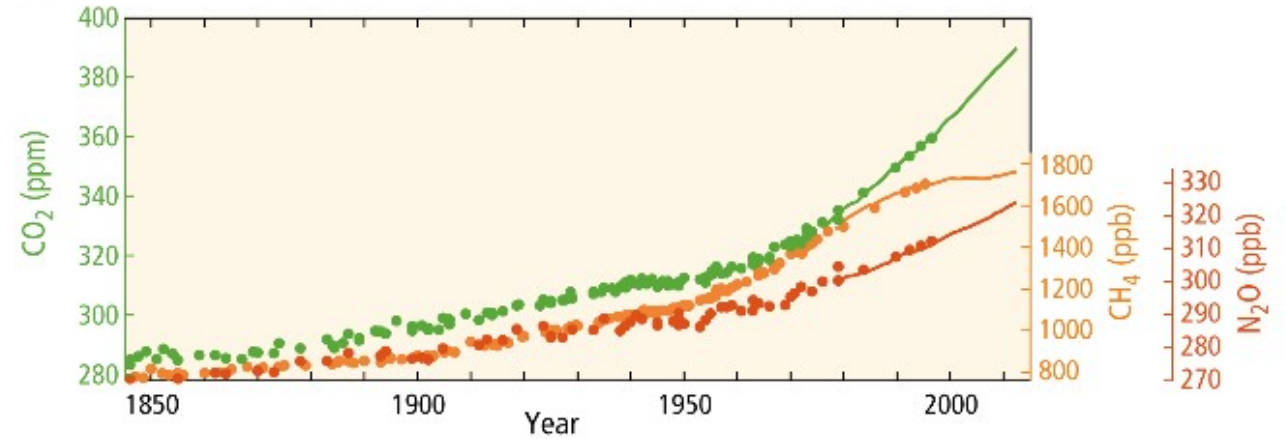
| Gas | Units | 1750 | 2010 |
|------------------|------------|---------|------|
| CO ₂ | <i>ppm</i> | 280 ppm | 410 |
| CH ₄ | <i>ppb</i> | 500 ppb | 1750 |
| N ₂ O | <i>ppb</i> | 250 ppb | 325 |
| CFC's | <i>ppt</i> | 0 ppt | 1000 |

The trends

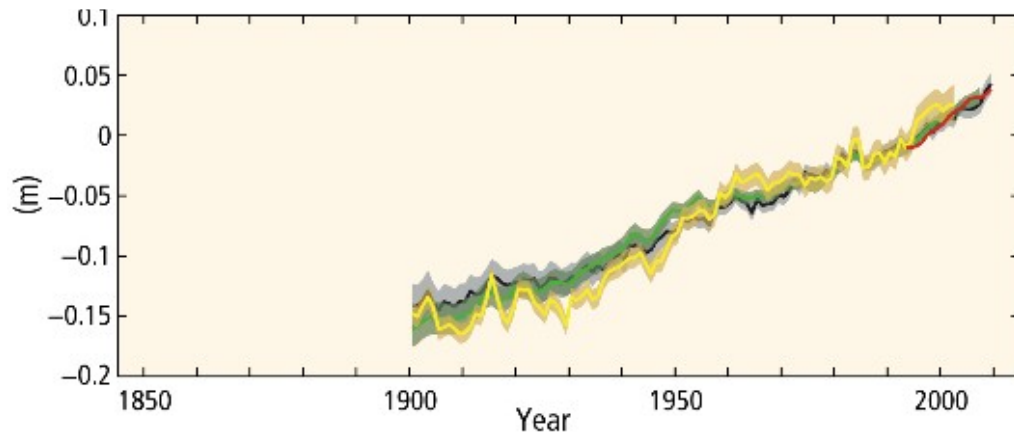
Temperature change



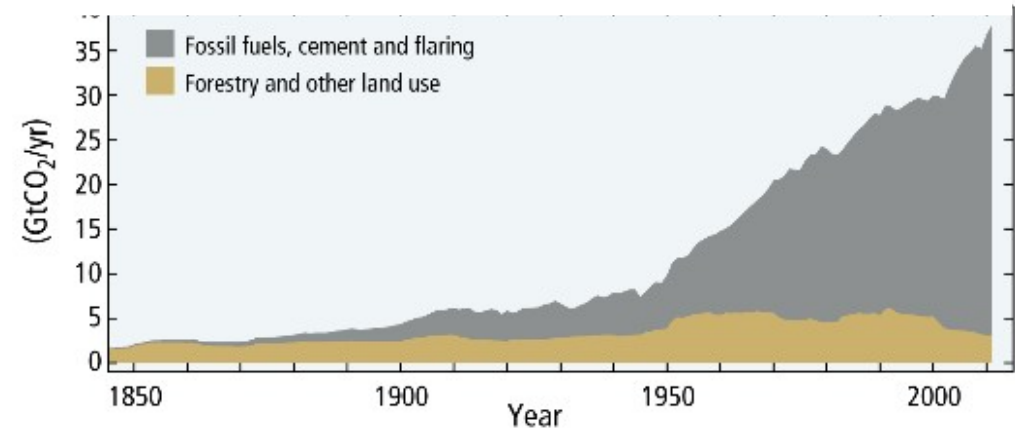
Greenhouse gas concentrations



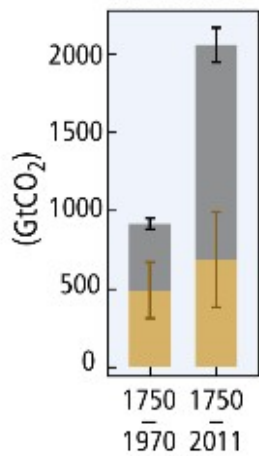
Sea level rise



CO₂ emissions

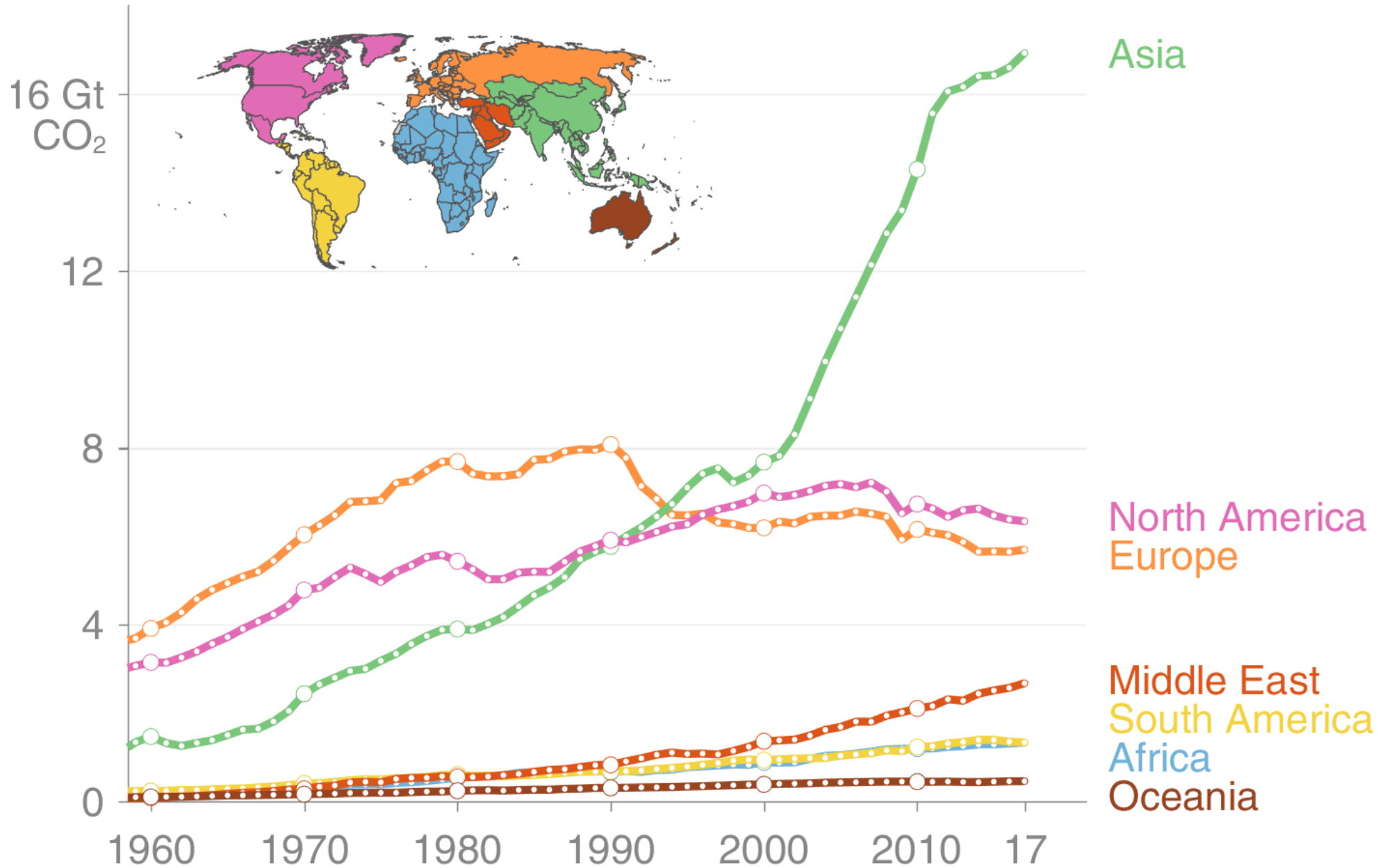


Cumulative CO₂ emissions

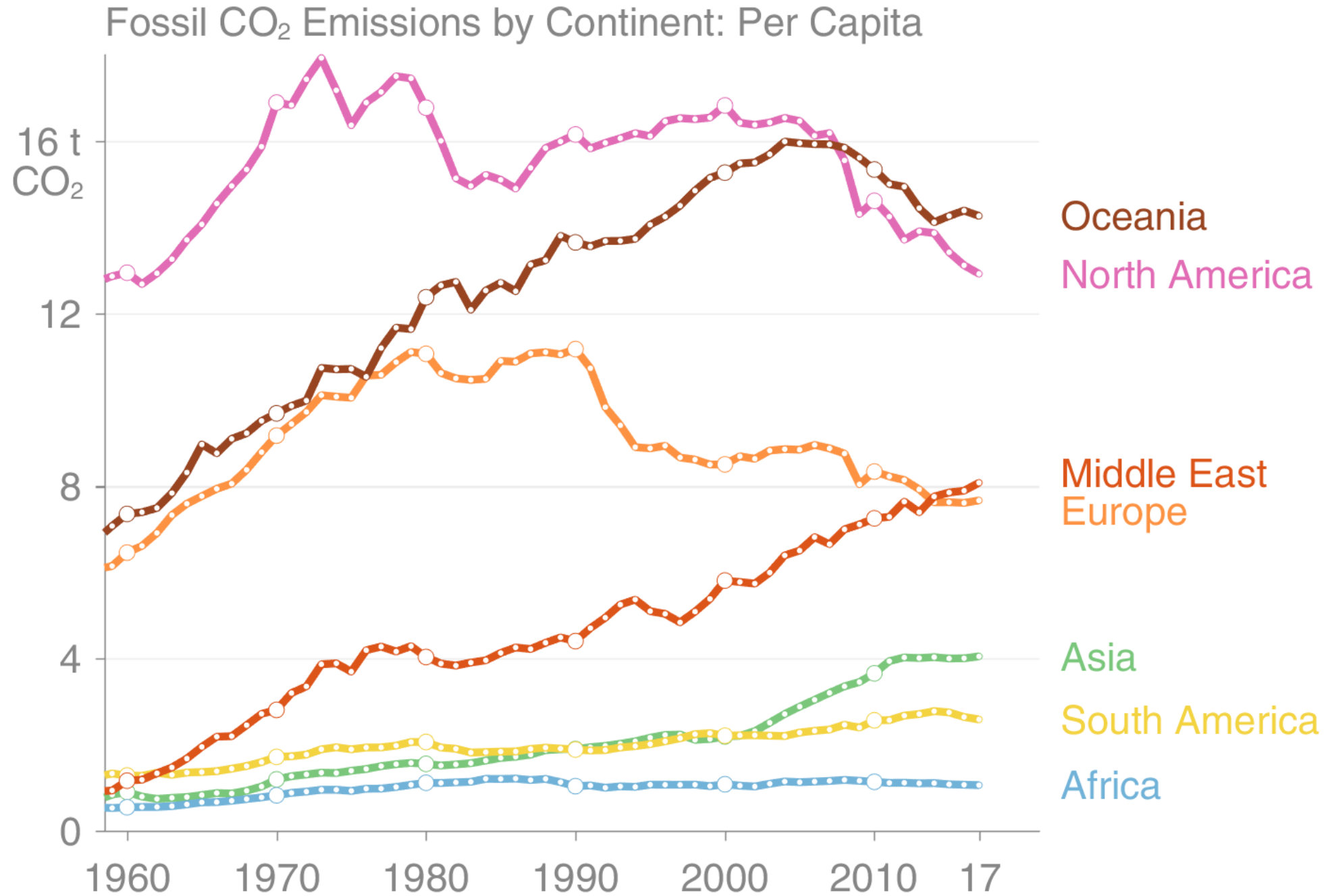


Who emits? Total

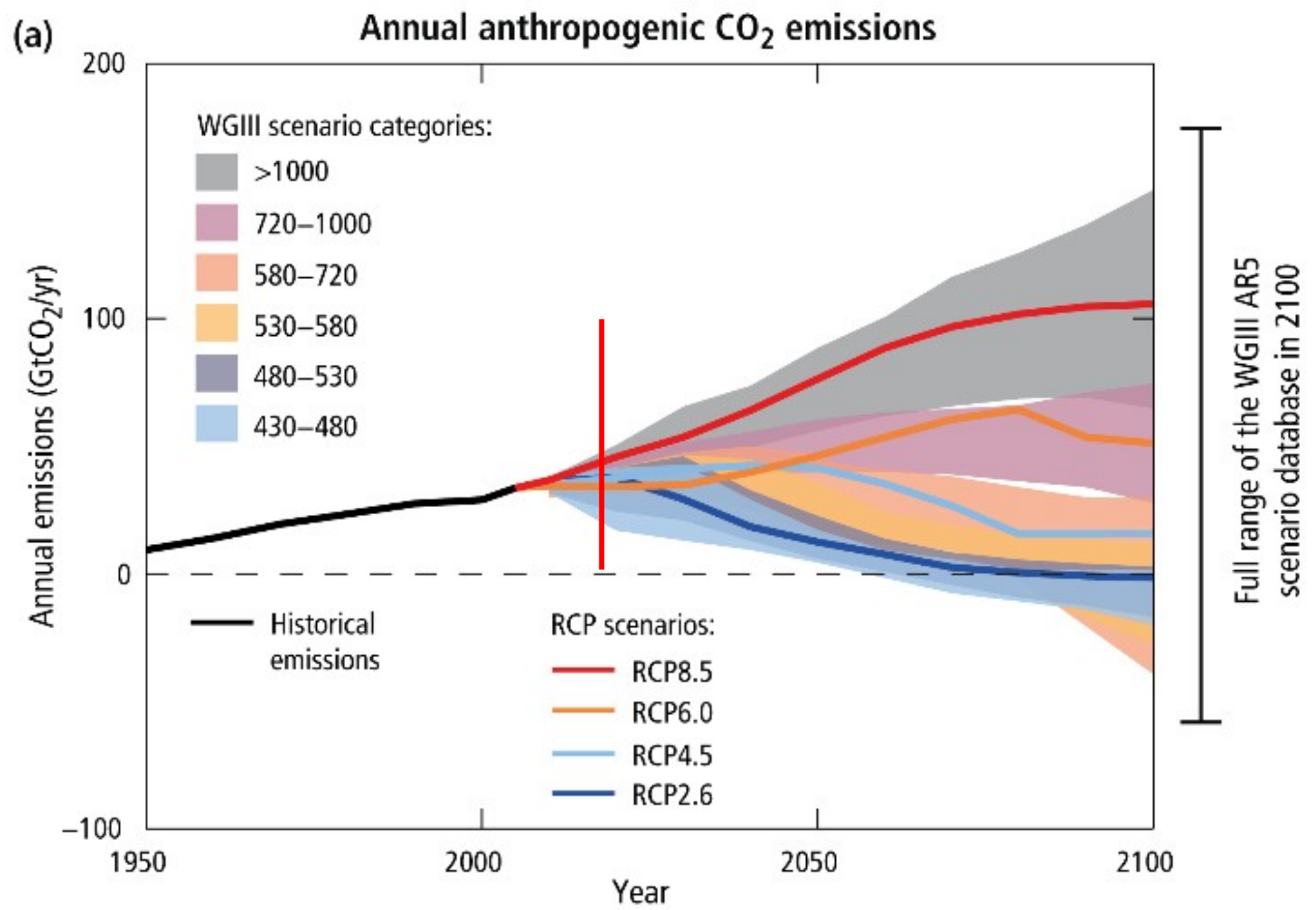
Fossil CO₂ Emissions by Continent



Who emits? Per person

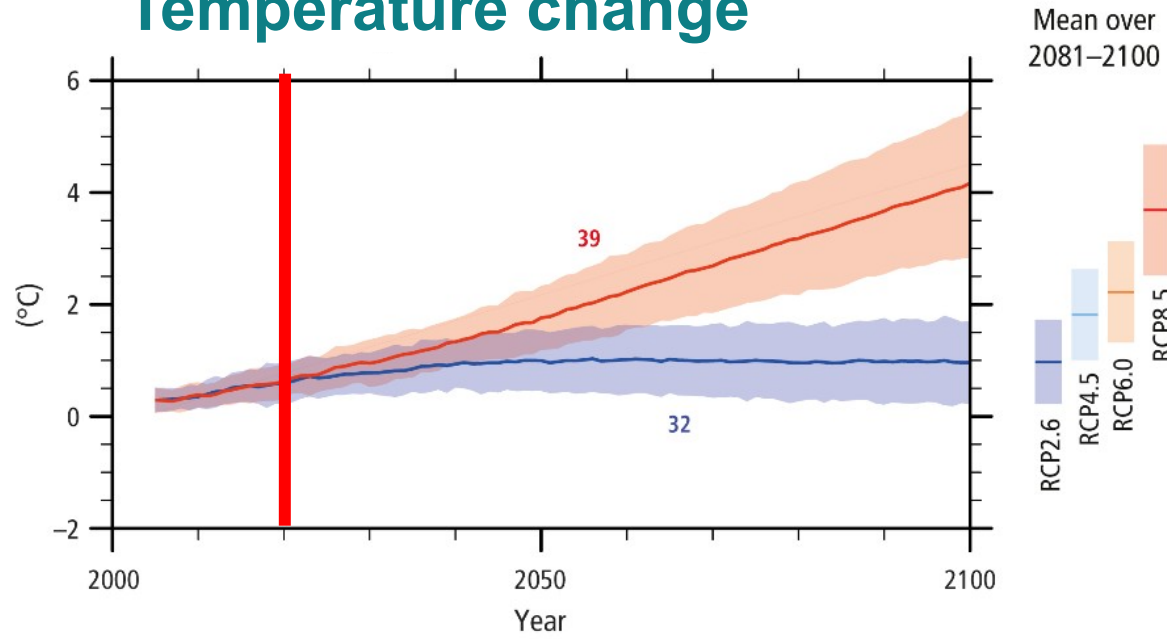


Emission forecasts

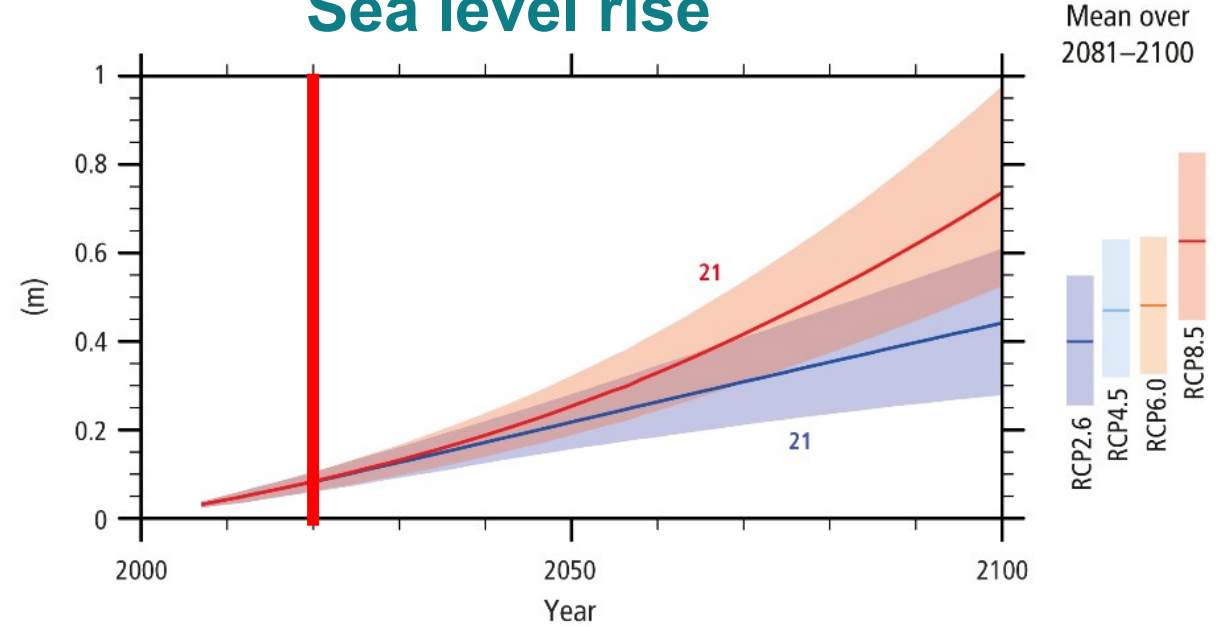


Temperature and sea level changes

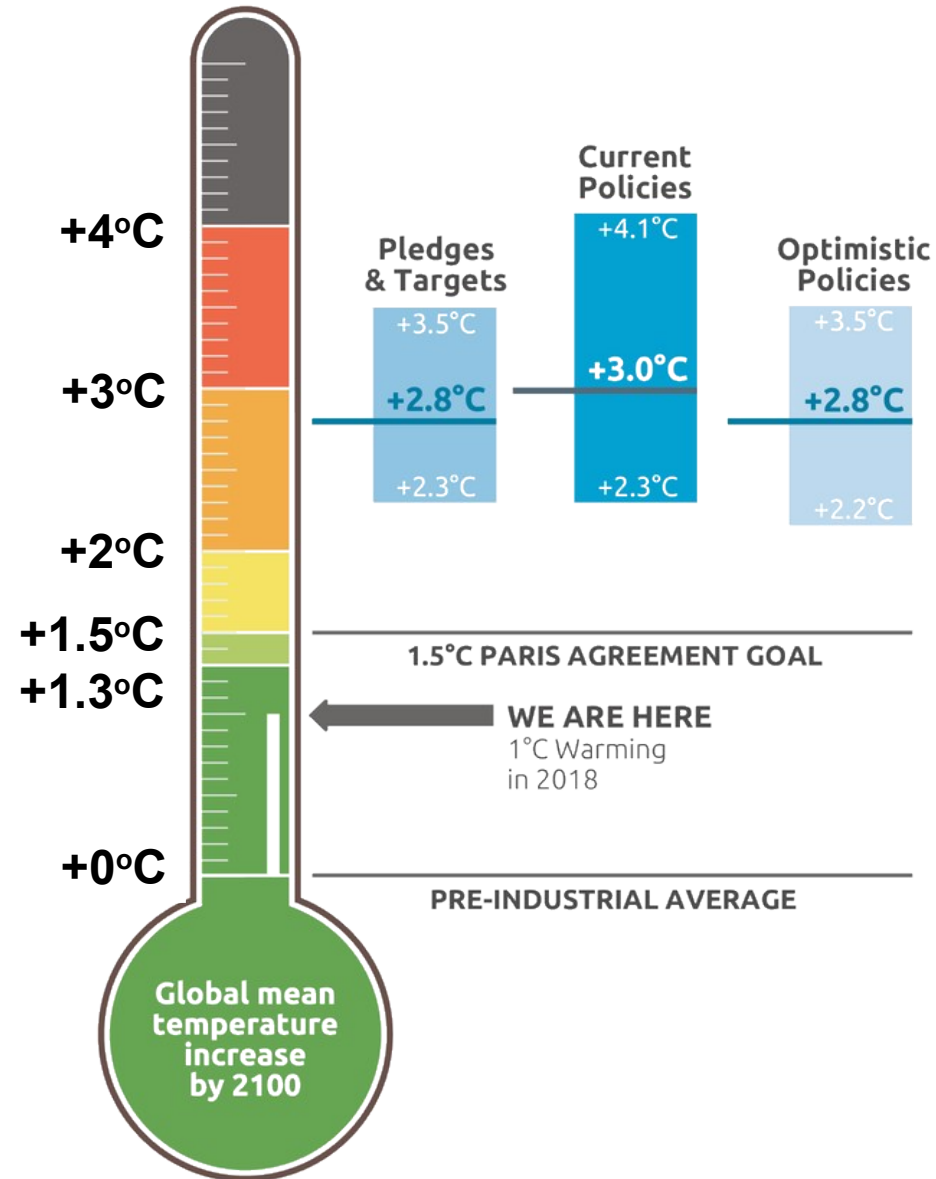
Temperature change



Sea level rise



Action and targets



CAT warming projections
Global temperature increase by 2100

December 2019 Update

Impacts and risks

Impacts and risks for selected natural, managed and human systems

