

The Basics of Climate Change

**GLOBAL WARMING &
GHGs**





CAUSES

Human activities and Greenhouse Gases

Overpopulation, pollution, burning fossil fuels, and deforestation

The **concentration of GHGs** has been rising steadily since the time of the Industrial Revolution as a **result of human activity**, primarily the burning of fossil fuels and changes in land use, leading to increasing global temperatures. (IPCC)

'Greenhouse gases constitute a group of gases contributing to global warming and climate change'

(europa.eu)

OXYGEN AND NITROGEN

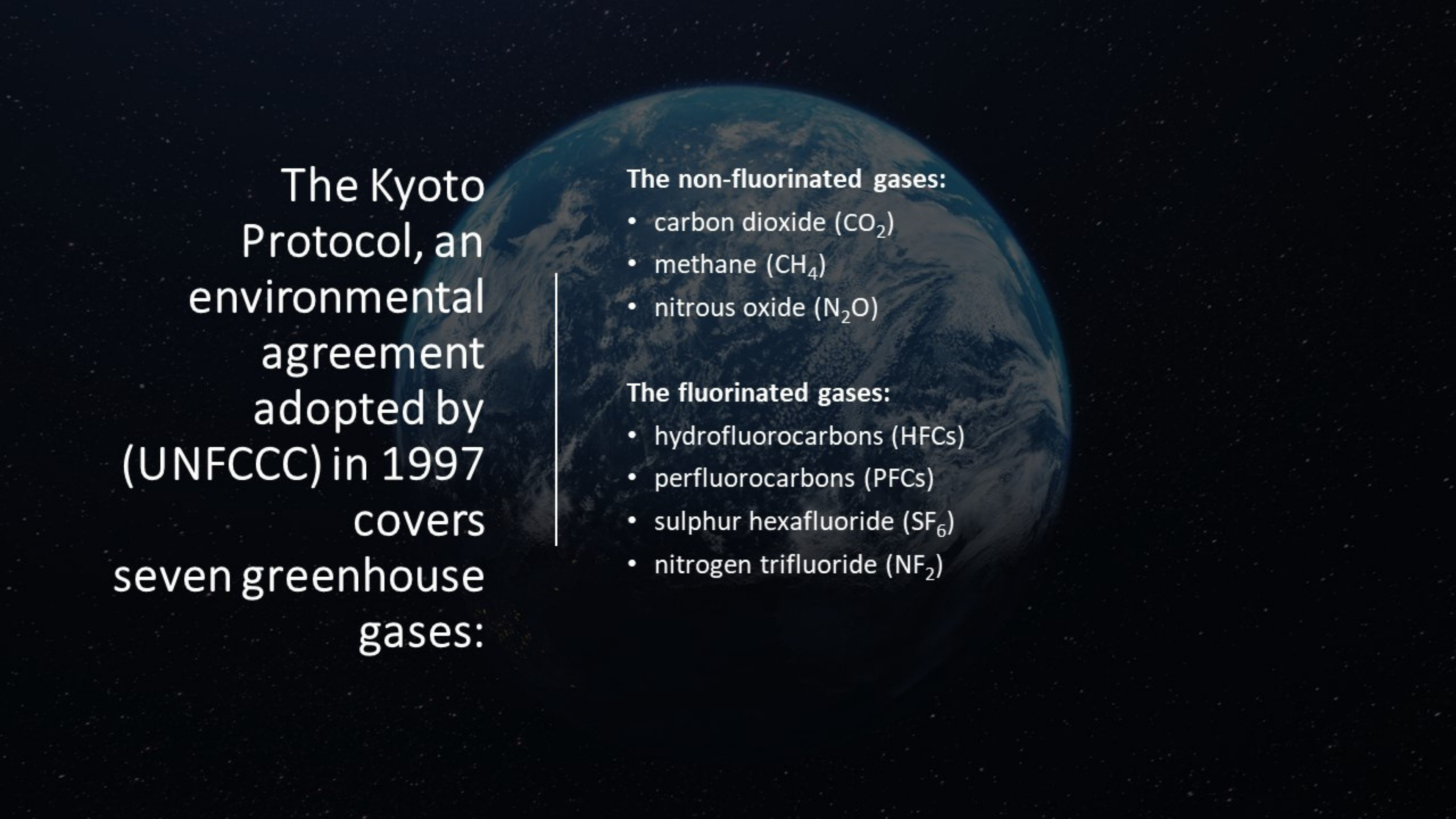
'While oxygen is necessary for most life on Earth, the majority of Earth's atmosphere is not oxygen. Earth's atmosphere is composed of about 78 percent nitrogen, 21 percent oxygen, 0.9 percent argon, and 0.1 percent other gases.'

(nationalgeographic.org)



GREENHOUSE GASES

Carbon Dioxide (CO₂)
Methane (CH₄)
Nitrous oxide (N₂O)
Hydrofluorocarbons (HFCs)
Perfluorocarbons (PFCs)
Sulphur hexafluoride (SF₆)
Nitrogen trifluoride (NF₃)



The Kyoto Protocol, an environmental agreement adopted by (UNFCCC) in 1997 covers seven greenhouse gases:

The non-fluorinated gases:

- carbon dioxide (CO_2)
- methane (CH_4)
- nitrous oxide (N_2O)

The fluorinated gases:

- hydrofluorocarbons (HFCs)
- perfluorocarbons (PFCs)
- sulphur hexafluoride (SF_6)
- nitrogen trifluoride (NF_3)

Methane (CH₄)

Methane is a powerful greenhouse gas, 25 times more potent than carbon dioxide at trapping heat in the atmosphere. Agricultural activities, waste management, energy use, and biomass burning all contribute to CH₄ emissions.

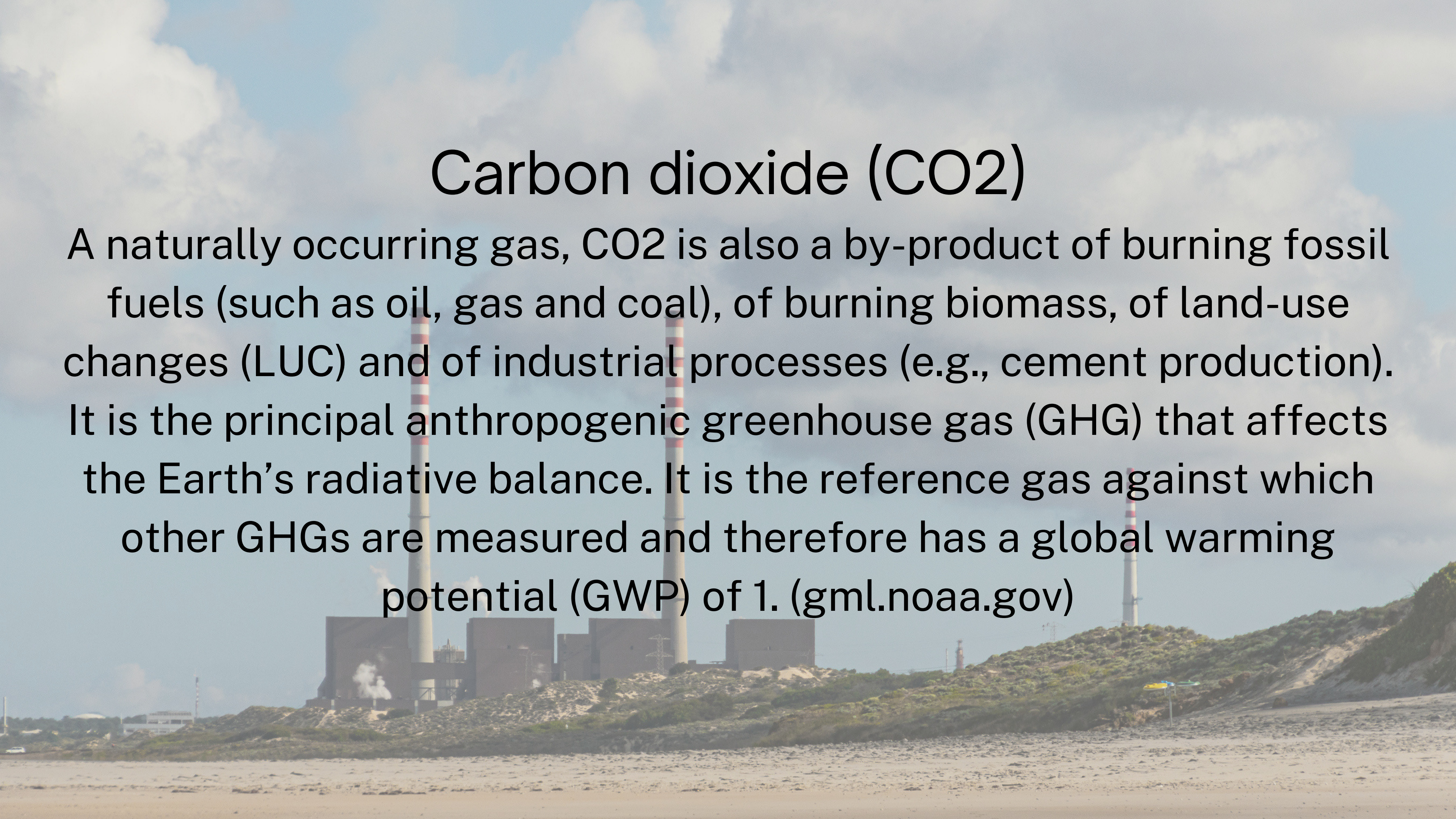
Nitrous oxide (N₂O): Agricultural activities, such as fertilizer use, are the primary source of N₂O emissions. Fossil fuel combustion also generates N₂O.

<https://gml.noaa.gov/aggi/>



Carbon dioxide (CO₂)

A naturally occurring gas, CO₂ is also a by-product of burning fossil fuels (such as oil, gas and coal), of burning biomass, of land-use changes (LUC) and of industrial processes (e.g., cement production). It is the principal anthropogenic greenhouse gas (GHG) that affects the Earth's radiative balance. It is the reference gas against which other GHGs are measured and therefore has a global warming potential (GWP) of 1. (gml.noaa.gov)



Greenhouse gases are gases that trap heat in the atmosphere, causing global warming and climate change. The main greenhouse gases released by human activity are **carbon dioxide, methane, and nitrous oxide, as well as fluorinated gases** used for cooling and refrigeration. To prevent catastrophic climate change, the world's governments must work together to significantly reduce greenhouse gas emissions and keep global warming below the dangerous threshold of 1.5°C. (undp.org)

Fluorinated gases (F-gases), FGHGs

Fluorinated gases (F-gases): Industrial processes, refrigeration, and the use of a variety of consumer products contribute to emissions of F-gases, which include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆). (epa.gov)

'F-gases have a range of applications, particularly in the refrigeration, air conditioning and heat pump sector. Most F-gases have much higher global warming potentials than other greenhouse gases.' (eea.europa.eu)

In a greenhouse, sunlight enters, and heat is retained. The greenhouse effect describes a similar phenomenon on a planetary scale but, instead of the glass of a greenhouse, certain gases are increasingly raising global temperatures.

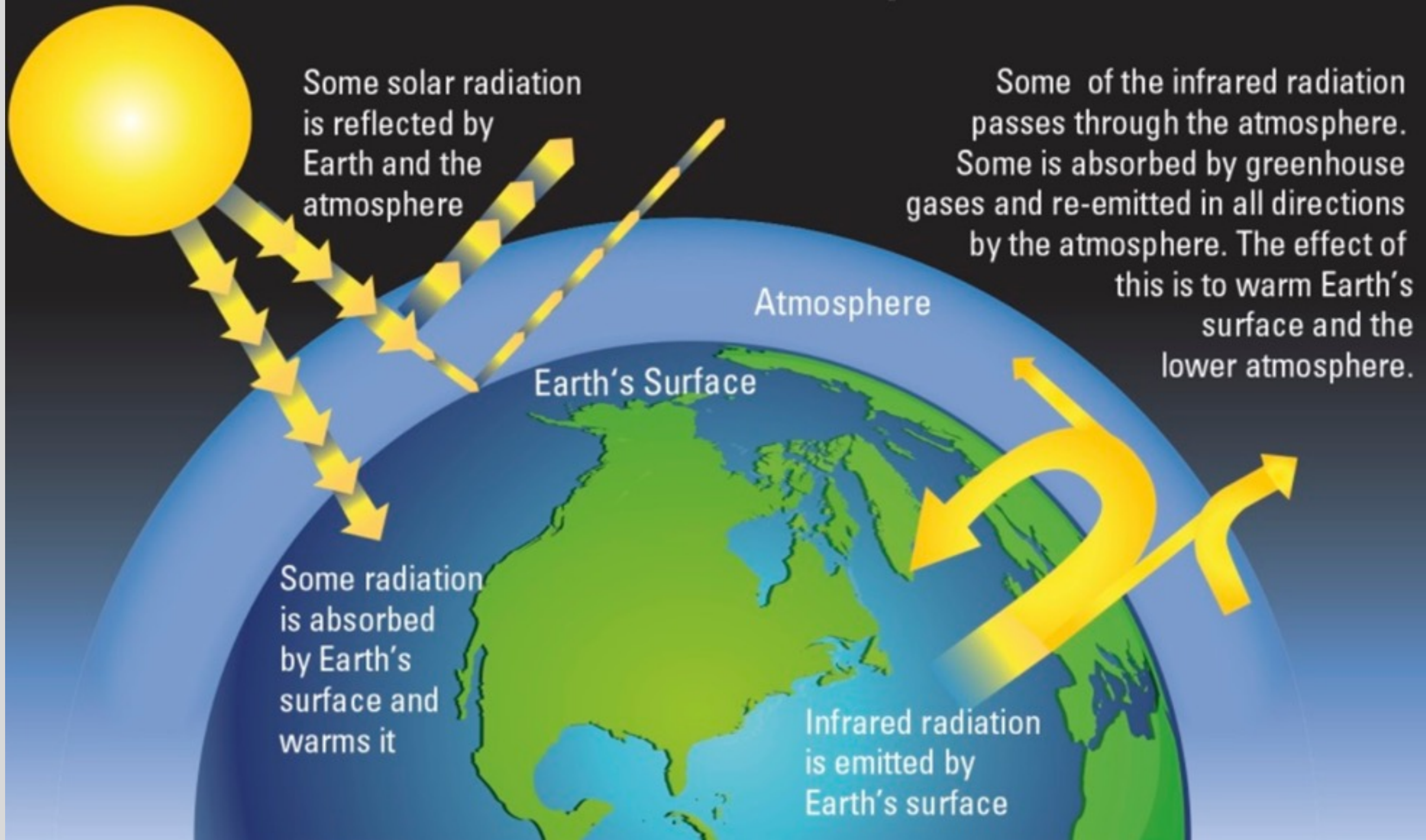
The surface of the Earth absorbs just under half of the sun's energy, while the atmosphere absorbs 23 per cent, and the rest is reflected back into space. Natural processes ensure that the amount of incoming and outgoing energy is equal, keeping the planet's temperature stable.



However, human activity is resulting in the increased emission of so-called greenhouse gases (GHGs) which, unlike other atmospheric gases such as oxygen and nitrogen, becomes trapped in the atmosphere, unable to escape the planet. This energy returns to the surface, where it is reabsorbed.

Because more energy enters than exits the planet, surface temperatures increase until a new balance is achieved. (un.org)

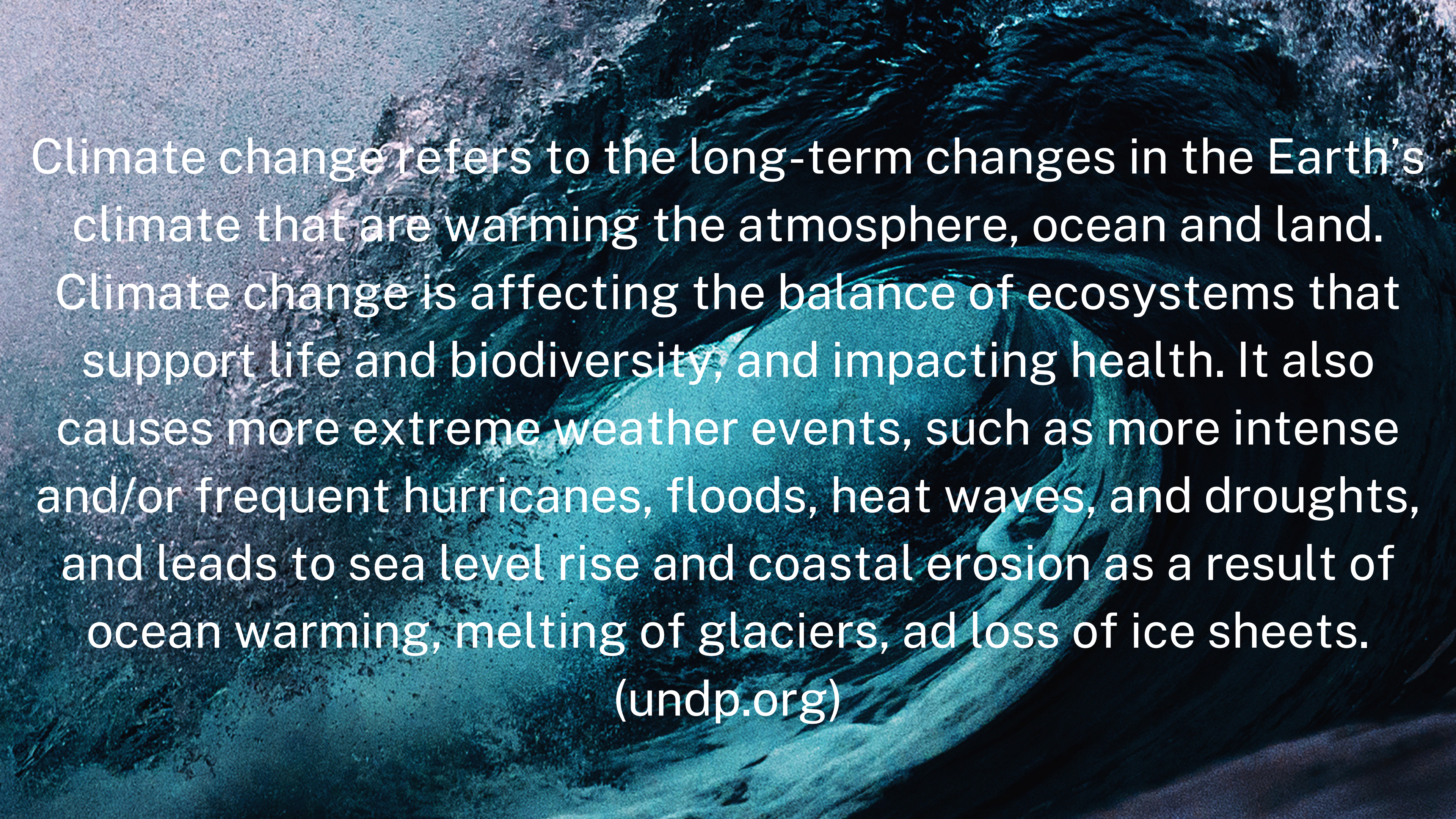
THE GREENHOUSE EFFECT



Global warming is an increase in the Earth's average surface temperature that occurs when the concentration of greenhouse gases in the atmosphere increases. These gases absorb more solar radiation and trap more heat, thus causing the planet to get hotter. Burning fossil fuels, cutting down forests, and farming livestock are some human activities that release greenhouse gases and contribute to global warming.

(undp.org)





Climate change refers to the long-term changes in the Earth's climate that are warming the atmosphere, ocean and land. Climate change is affecting the balance of ecosystems that support life and biodiversity, and impacting health. It also causes more extreme weather events, such as more intense and/or frequent hurricanes, floods, heat waves, and droughts, and leads to sea level rise and coastal erosion as a result of ocean warming, melting of glaciers, and loss of ice sheets.

(undp.org)

CLIMATE INDICATORS

'The current state of the climate can be understood through the use of climate indicators.' These indicators include

CO₂ Concentration

Ocean Acidification

Global mean surface temperature

Sea Level Rise

Sea-ice Extent

Glacier Mass Balance

Ocean Heat Content

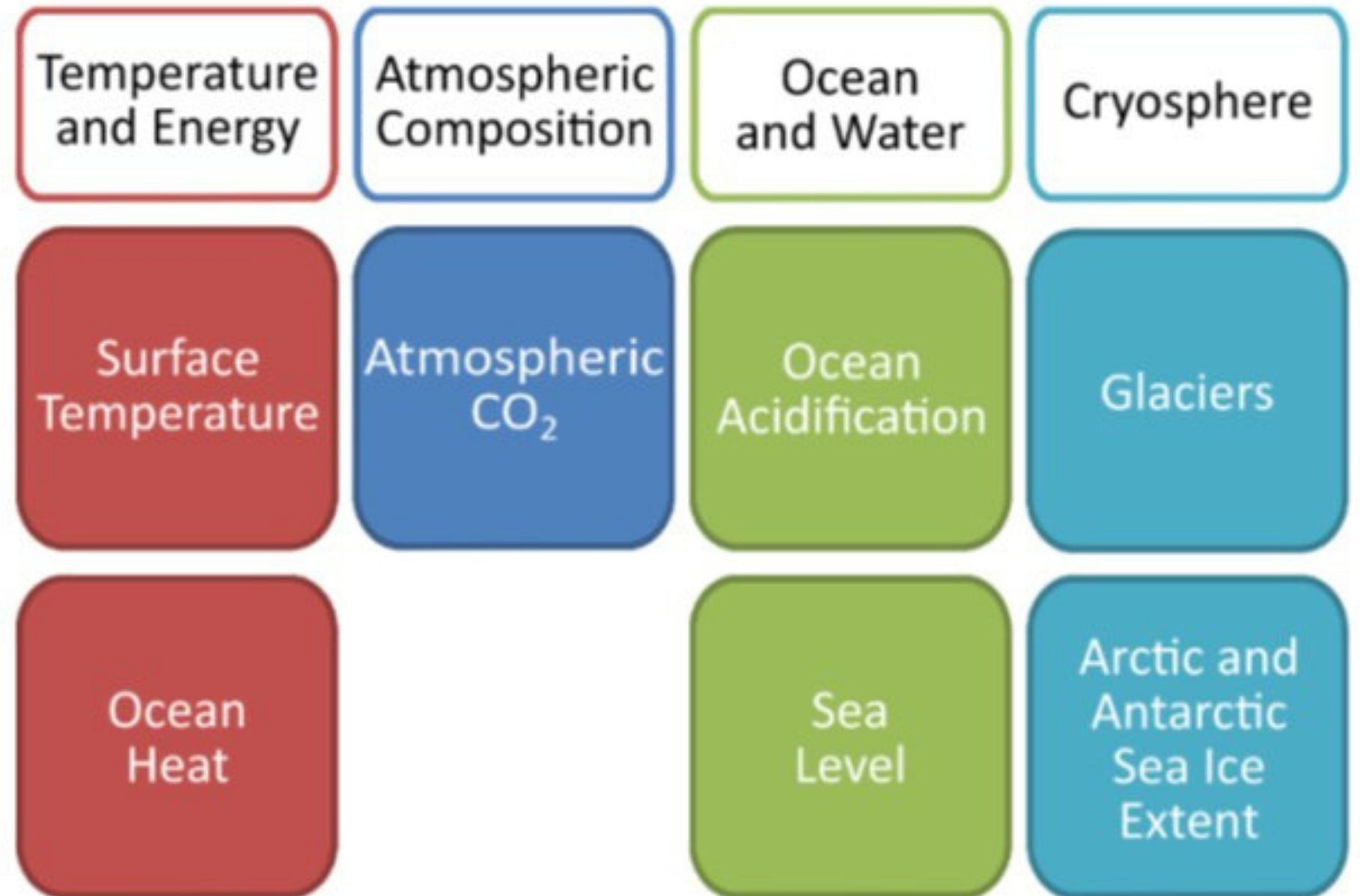
(WMO, 2022)

https://library.wmo.int/doc_num.php?explnum_id=11359

GLOBAL CLIMATE INDICATORS

'The **Global Climate Indicators** are a set of parameters that describe the changing climate without reducing climate change to only temperature. They comprise key information for the most relevant domains of climate change: temperature and energy, atmospheric composition, ocean and water as well as the cryosphere.' (wmo.int)

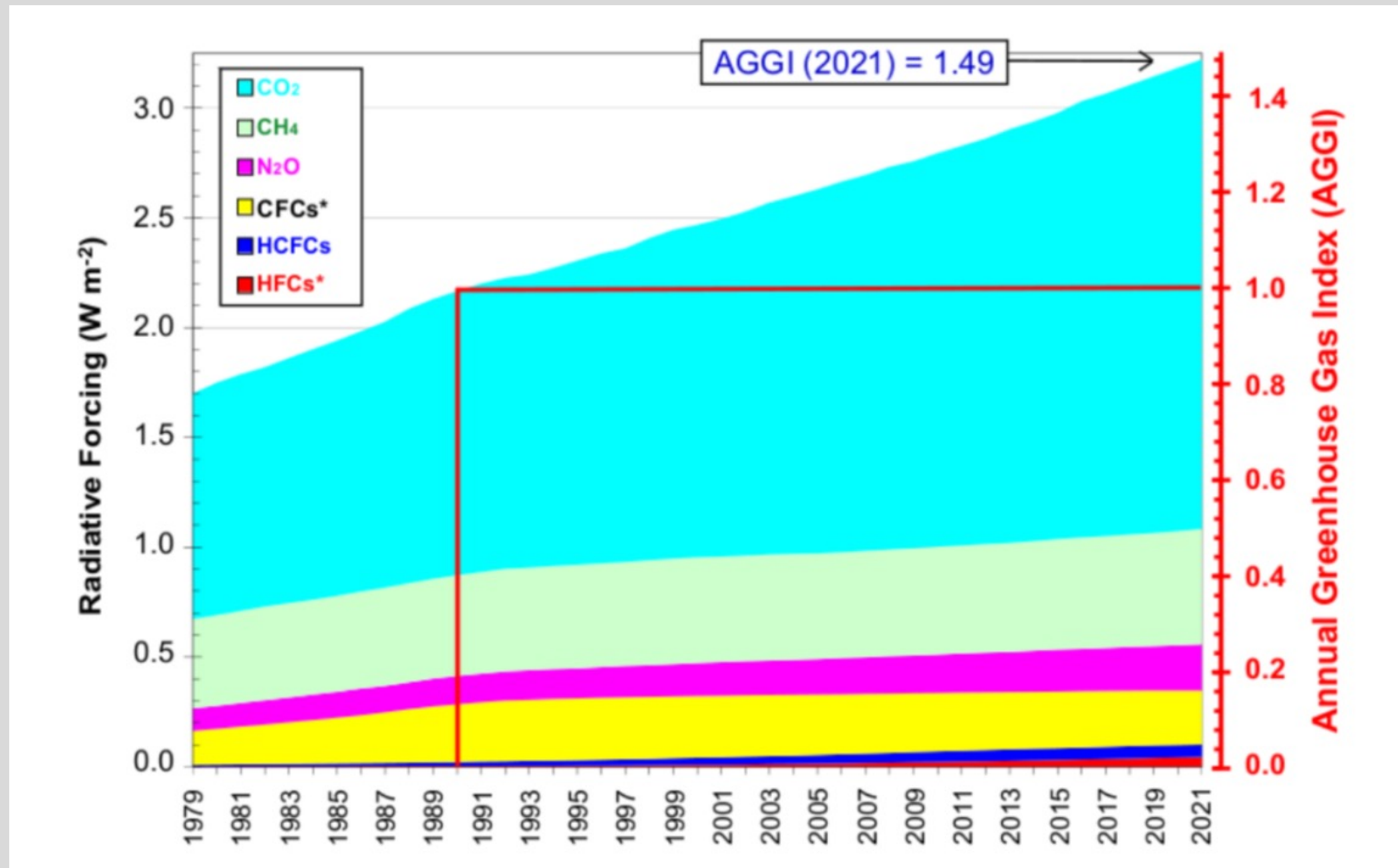
'...seven headline indicators are complemented by a set of subsidiary indicators that provide additional information and allow a more detailed picture of the changes in the respective domain.' (wmo.int)



IMPACTS

‘There is strong scientific evidence that human-induced greenhouse gas emissions are the main cause of climate change. **Through atmospheric and ocean warming, these emissions worsen extreme weather events, cause rising sea levels and other environmental changes which threaten people and nature around the world.**’ (UN)



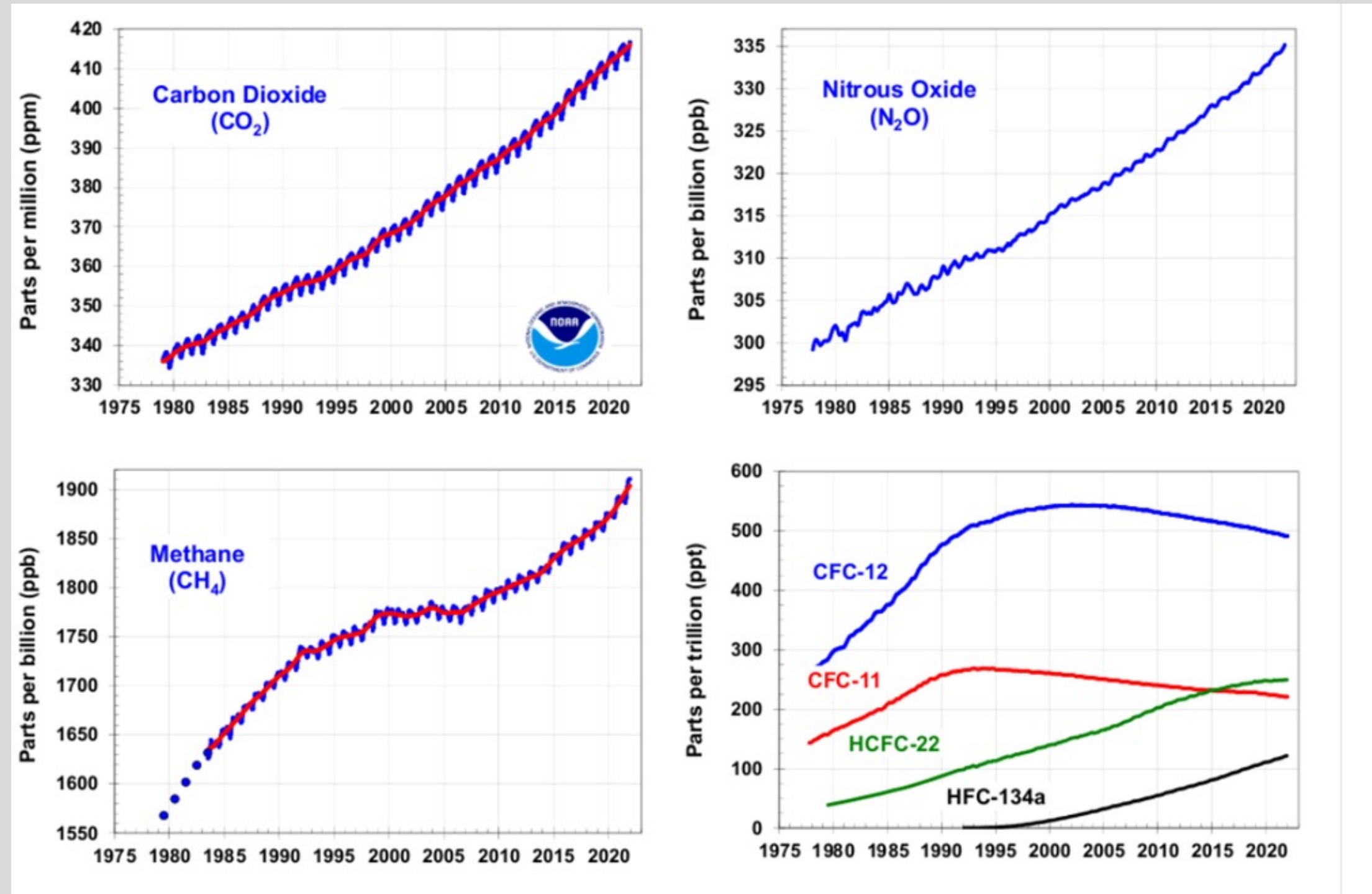


The AGGI is a measure of the climate-warming influence of long-lived trace gases in the atmosphere and how that influence has changed since the onset of the industrial revolution. The index was designed to enhance the connection between scientists and society by providing a normalized standard that can be easily understood and followed. The warming influence of long-lived greenhouse gases is well understood by scientists and has been reported by NOAA through a range of national and international assessments. Nevertheless, the language of scientists often eludes policy makers, educators, and the general public. This index is designed to help bridge that gap. The AGGI provides a way for this warming influence to be presented as a simple index. (gml.noaa.gov)

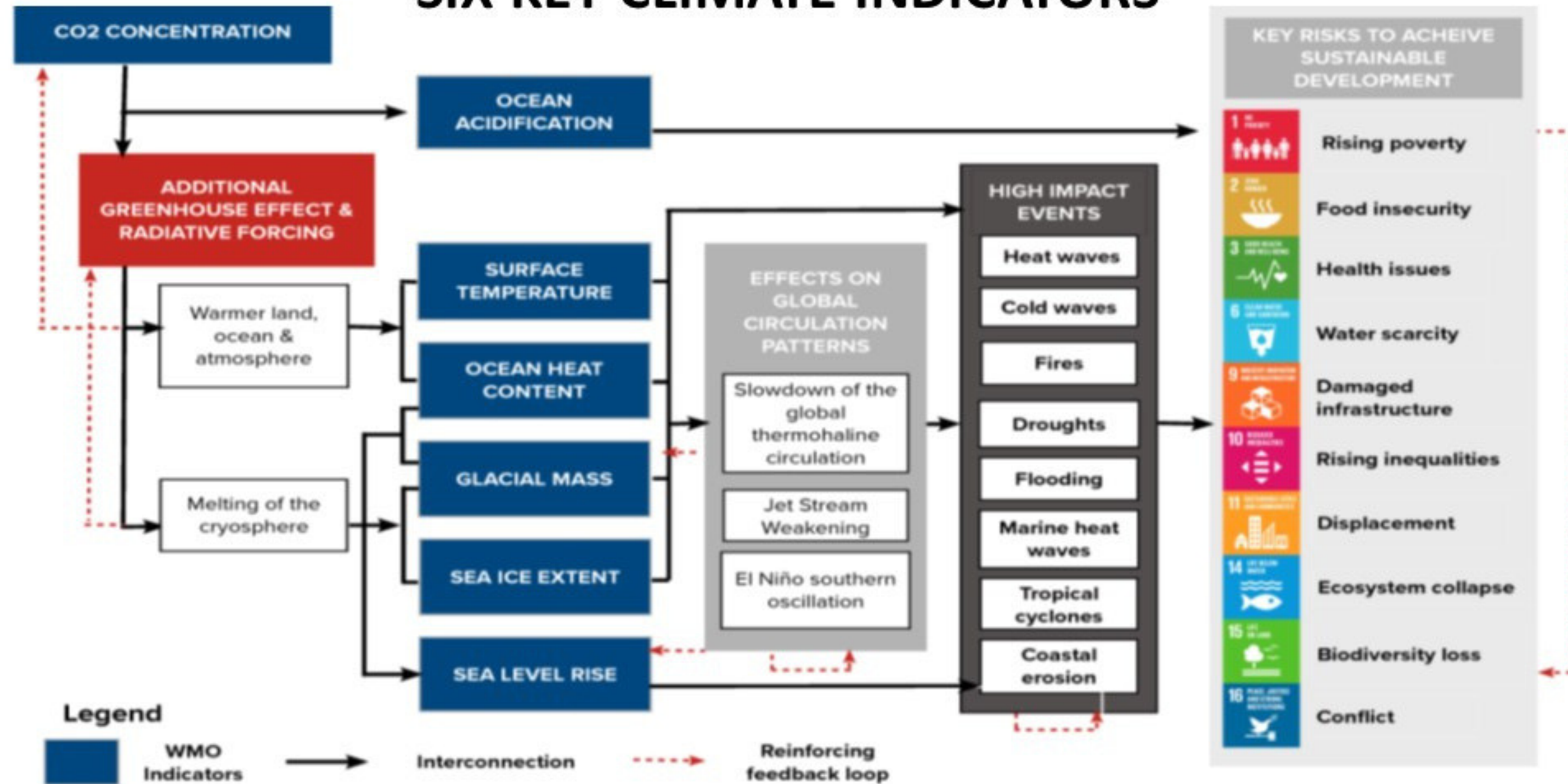
The NOAA Annual Greenhouse Gas Index (AGGI) measures the commitment society has already made to living in a changing climate. It is based on the highest quality atmospheric observations from sites around the world. Its uncertainty is very low.

Global average abundances of the major, well-mixed, long-lived greenhouse gases - carbon dioxide, methane, nitrous oxide, CFC-12 and CFC-11 - from the NOAA global air sampling network since the beginning of 1979. These five gases account for about 96% of the direct radiative forcing by long-lived greenhouse gases since 1750.

The atmospheric abundance of CO₂ has increased by an average of 1.88 ppm per year over the past 42 years (1979-2021)(gml.noaa.gov)

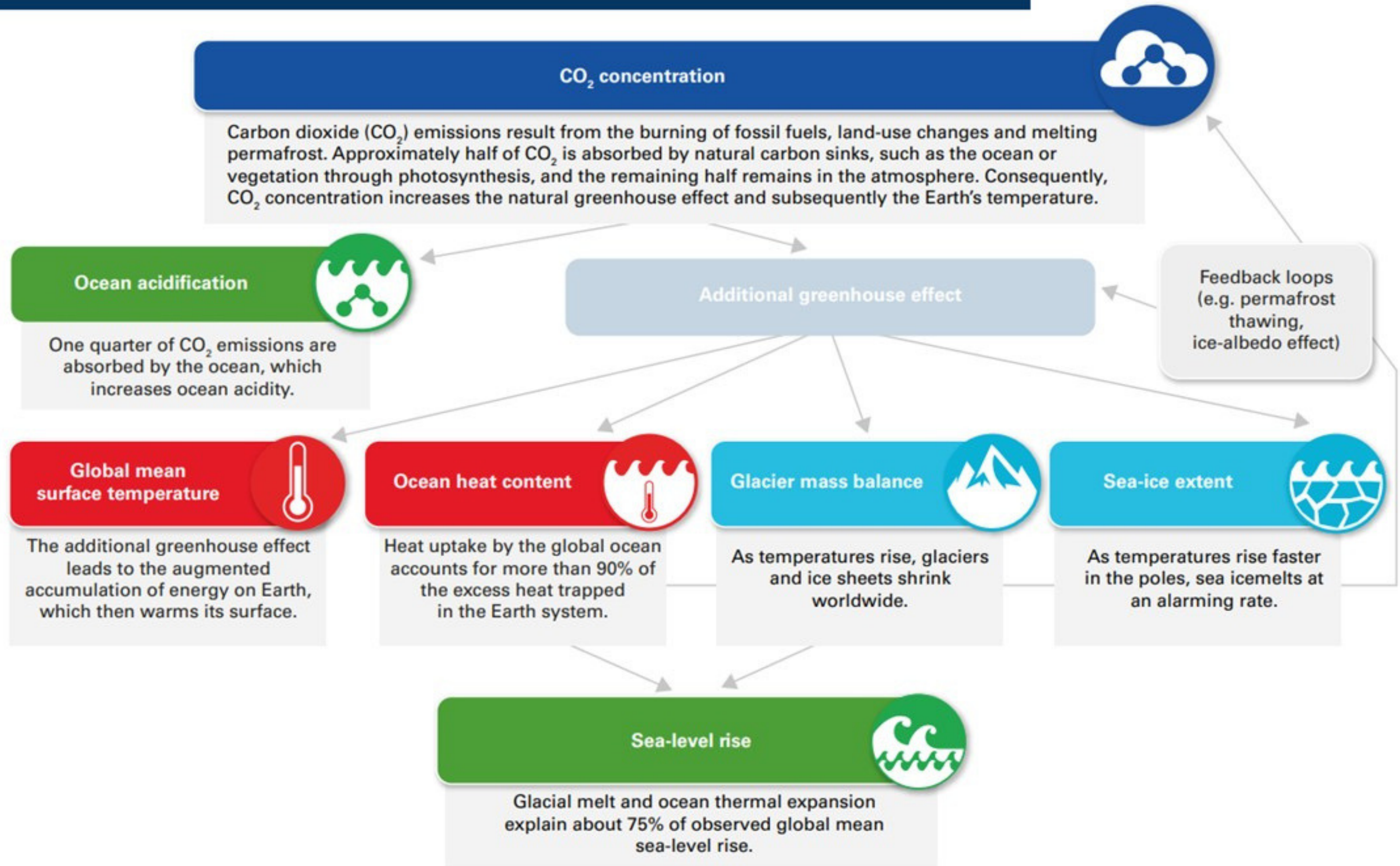


RISING ATMOSPHERIC CO₂ CONCENTRATIONS AND SIX KEY CLIMATE INDICATORS



Rising atmospheric CO₂ concentrations lead to cascading effects via six of the other key climate indicators that perpetuate warming and contribute to high impact events, risking the achievement of the Sustainable Development Goals (SDGs). (storymaps.arcgis.com/)

Interconnections between the WMO climate indicators





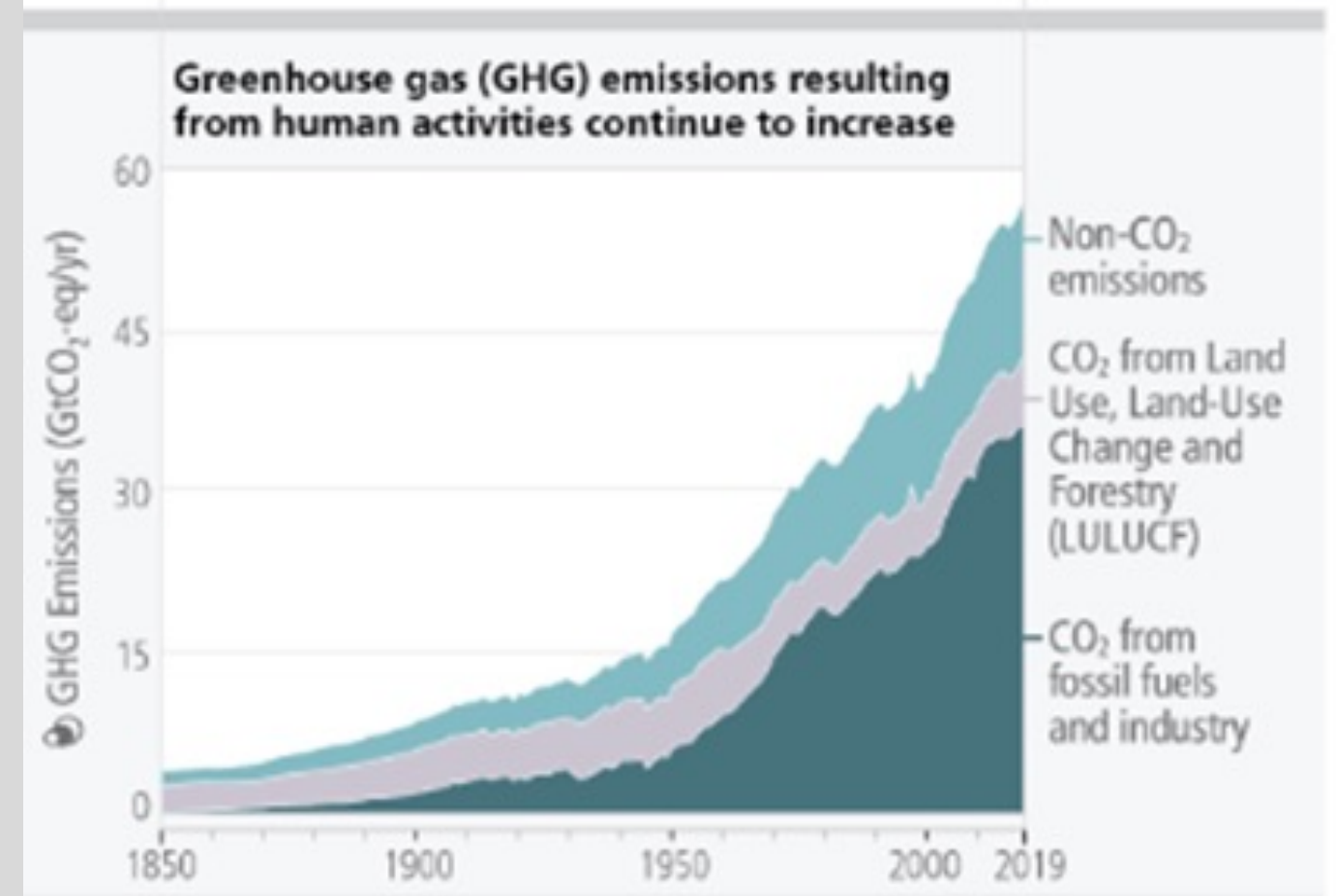
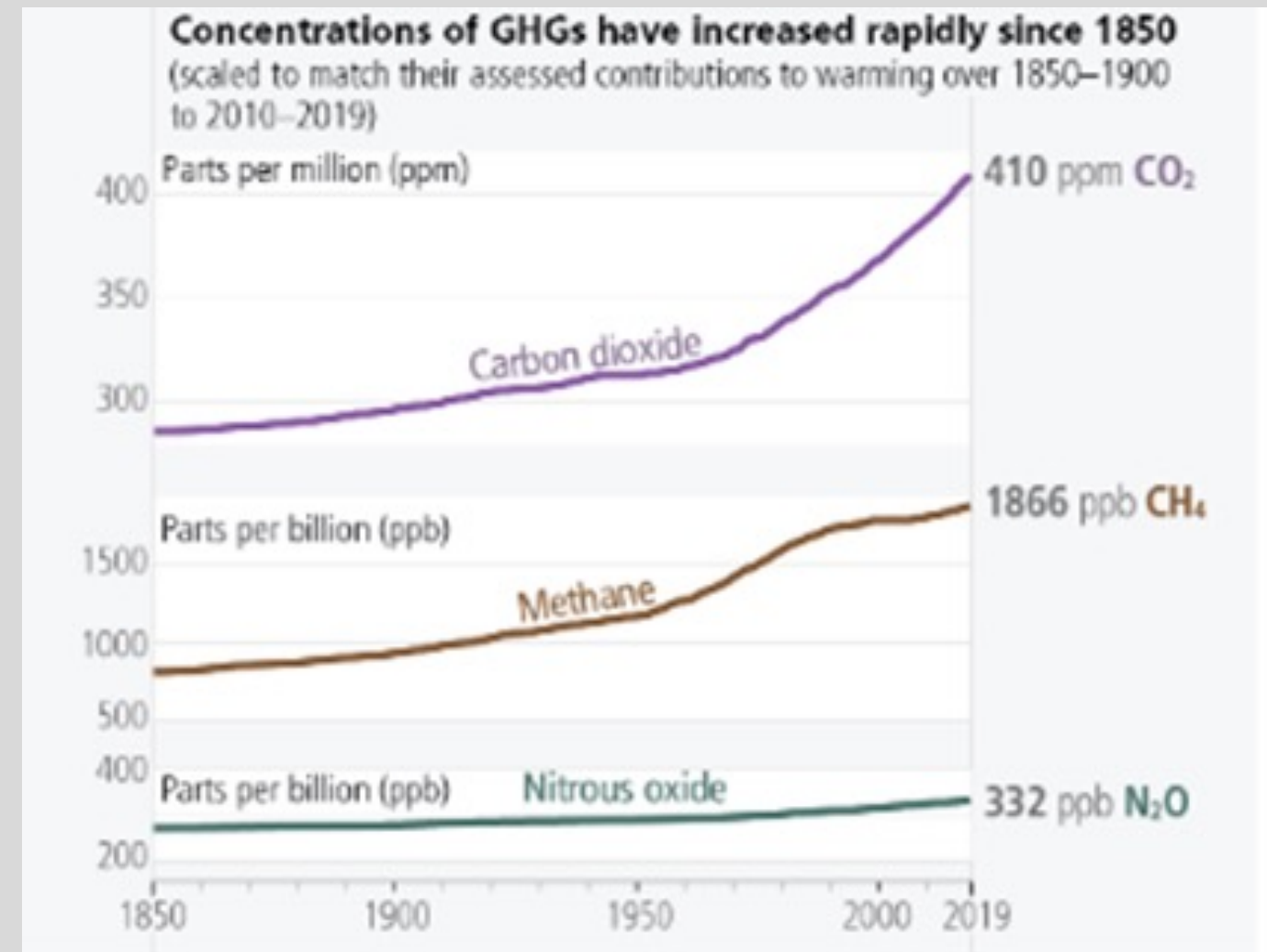
Some countries produce much more than others

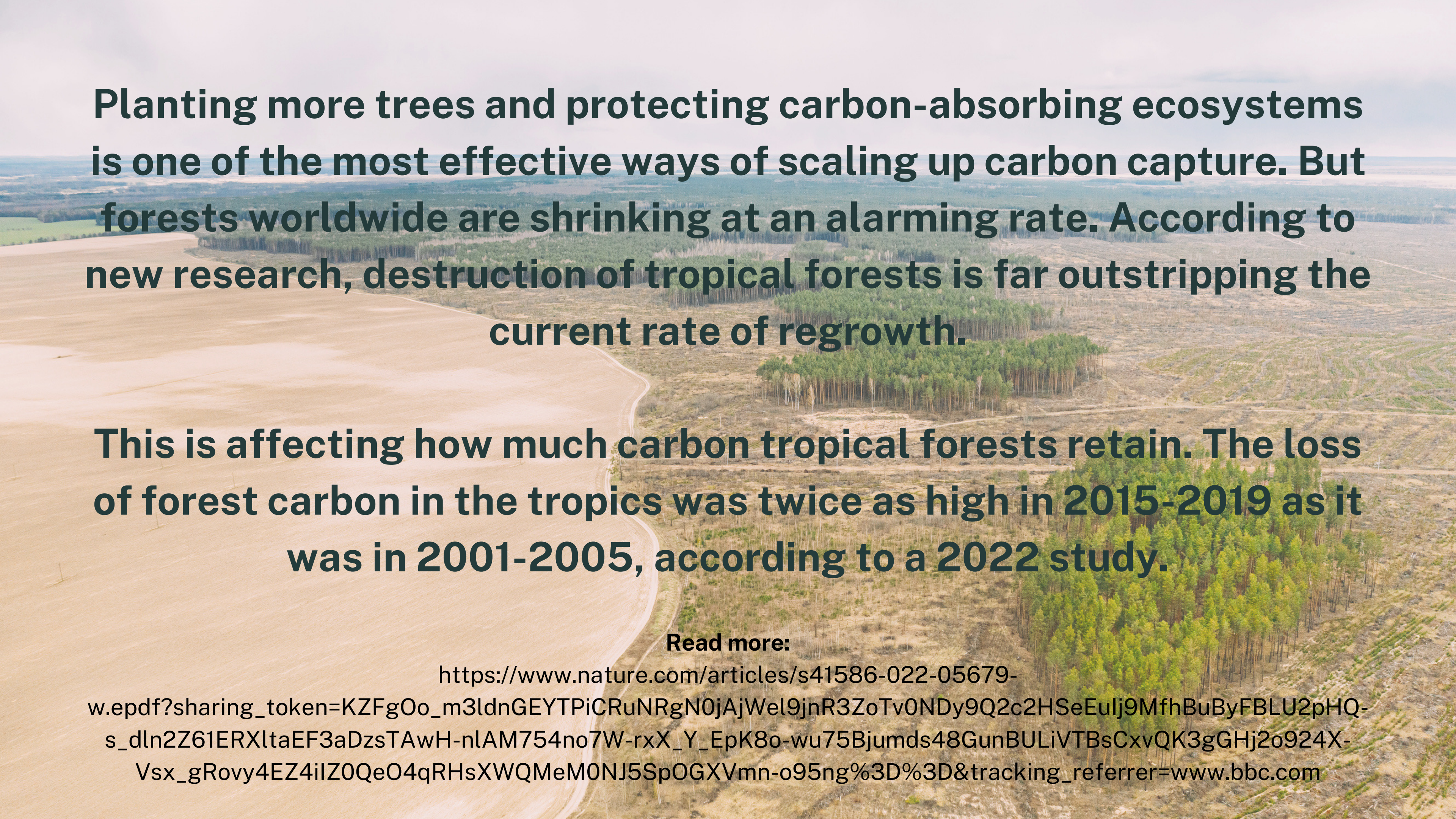
The 100 least-emitting countries generate 3 per cent of total emissions. The 10 countries with the largest emissions contribute 68 per cent.

People and countries creating more of the problem have a greater responsibility to act first.

Continued greenhouse gas emissions will lead to increasing global warming, with the best estimate of reaching 1.5°C in the near term in considered scenarios and modelled pathways.

Every increment of global warming will intensify multiple and concurrent hazards (high confidence). Deep, rapid, and sustained reductions in greenhouse gas emissions would lead to a discernible slowdown in global warming within around two decades, and also to discernible changes in atmospheric composition within a few years (high confidence). (IPCC, 2023)



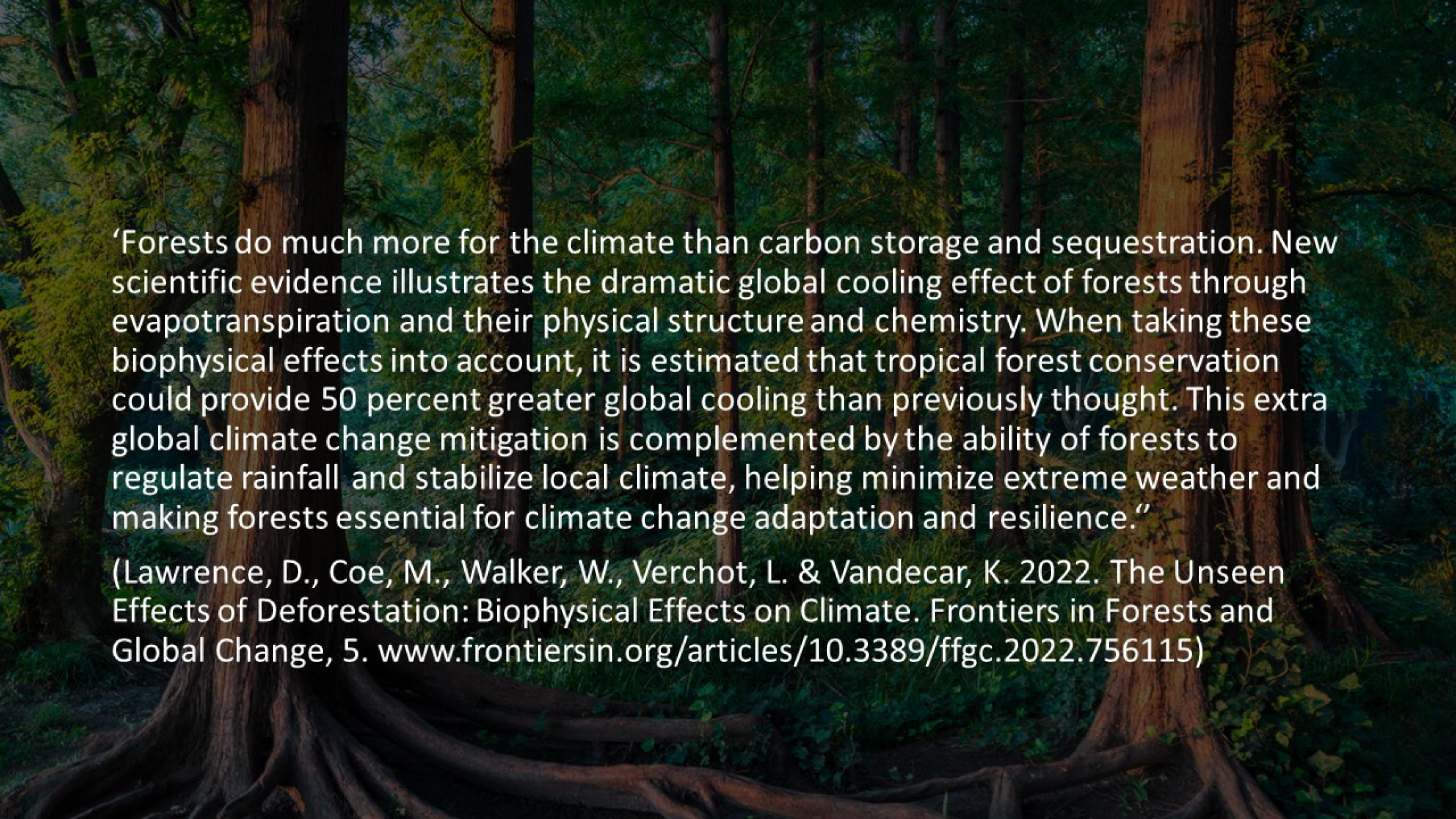


Planting more trees and protecting carbon-absorbing ecosystems is one of the most effective ways of scaling up carbon capture. But forests worldwide are shrinking at an alarming rate. According to new research, destruction of tropical forests is far outstripping the current rate of regrowth.

This is affecting how much carbon tropical forests retain. The loss of forest carbon in the tropics was twice as high in 2015-2019 as it was in 2001-2005, according to a 2022 study.

Read more:

https://www.nature.com/articles/s41586-022-05679-w.epdf?sharing_token=KZFG0o_m3ldnGEYTPiCRuNRgN0jAjWel9jnR3ZoTv0NDy9Q2c2HSeEulj9MfhBuByFBLU2pHQ-s_dln2Z61ERXltaEF3aDzsTAWH-nlAM754no7W-rxX_Y_EpK8o-wu75Bjumds48GunBULiVTBsCxxvQK3gGHj2o924X-Vsx_gRovy4EZ4ilZ0Qe04qRHsXWQMeM0NJ5SpOGXVmn-o95ng%3D%3D&tracking_referrer=www.bbc.com

A photograph of a forest with tall, thin trees and thick, gnarled roots in the foreground. The text is overlaid on the image.

‘Forests do much more for the climate than carbon storage and sequestration. New scientific evidence illustrates the dramatic global cooling effect of forests through evapotranspiration and their physical structure and chemistry. When taking these biophysical effects into account, it is estimated that tropical forest conservation could provide 50 percent greater global cooling than previously thought. This extra global climate change mitigation is complemented by the ability of forests to regulate rainfall and stabilize local climate, helping minimize extreme weather and making forests essential for climate change adaptation and resilience.’

(Lawrence, D., Coe, M., Walker, W., Verchot, L. & Vandecar, K. 2022. The Unseen Effects of Deforestation: Biophysical Effects on Climate. *Frontiers in Forests and Global Change*, 5. www.frontiersin.org/articles/10.3389/ffgc.2022.756115)