2.1 INTRODUCTION TO CLIMATE CHANGE

The greenhouse effect and global warming

Important notice
This unit is part of a package of learning materials designed to support understanding of foundational concepts relating to climate-related financial disclosures. These learning materials do not constitute application or regulatory guidance for the preparation of climate-related financial disclosures and are not intended to represent legal or professional advice. We encourage you to seek your own professional advice to find out how the Corporations Act 2001 (Corporations Act) and other relevant laws may apply to you and your circumstances, as it is your responsibility to determine your obligations and comply with them.

Key topics

- Carbon cycle
- Greenhouse effect
- Anthropogenic global warming

Relevance for climate-related disclosures

Foundational concepts in climate science are important to understanding drivers of climate-related risks and opportunities.

In this unit, you will learn about the carbon cycle, greenhouse effect and anthropogenic global warming. These concepts are foundational to understanding how human activities have impacted Earth and driven global warming since the Industrial Revolution.

Overview

Earth's carbon cycle moves carbon between Earth's atmosphere, the ocean, land and all living organisms. It is intrinsically linked to the greenhouse effect which helps regulate Earth's temperature and sustain all life on Earth.

Certain levels of greenhouse gases (explored further in Module 2, Unit 2) in the atmosphere are necessary. However, human activities since the Industrial Revolution have increased the concentration of greenhouse gases in the atmosphere, intensifying the greenhouse effect and warming the climate. Anthropogenic global warming is caused by emissions derived from human activities, primarily the burning of fossil fuels (coal, oil and gas).

What is the carbon cycle?

Carbon is a basic building block of all life on Earth and also plays a vital role in regulating the planet's temperature. Carbon is constantly exchanged between the atmosphere, the ocean, living matter and land through the carbon cycle. There is a fast and slow carbon cycle.

Fast carbon cycle: the exchange of carbon between the atmosphere, living matter and the upper layer of the ocean. This includes through photosynthesis, where plants and phytoplankton

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(microscopic ocean organisms) use energy from the sun to convert carbon dioxide into sugar and oxygen.

Slow carbon cycle: carbon gradually moves between the Earth's crust and upper mantle, the atmosphere, and ocean over a period of 100 to 200 million years.[1]

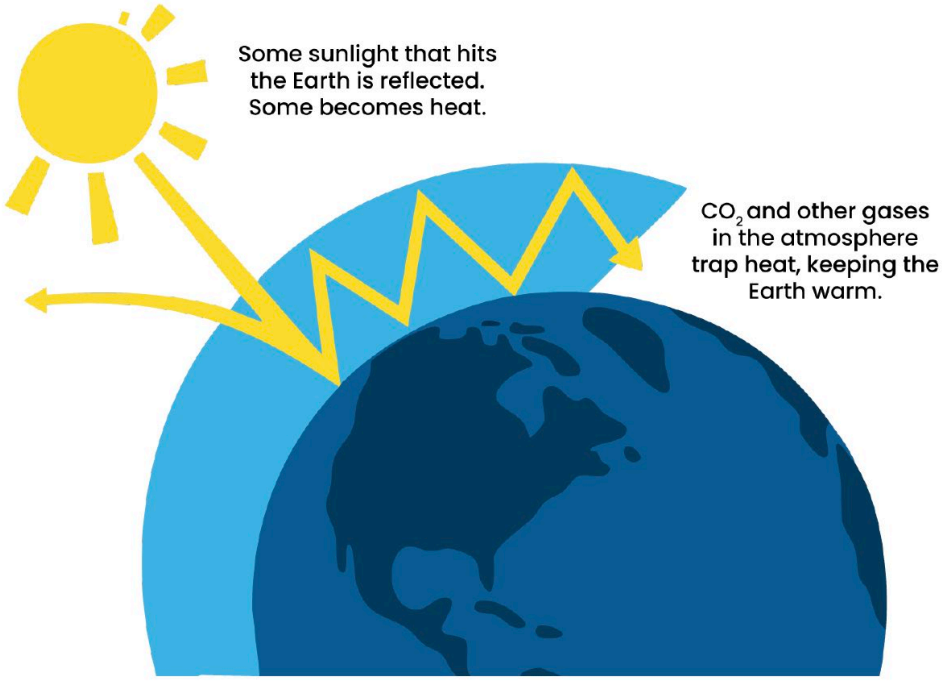
What is the greenhouse effect?

The greenhouse effect is directly linked to the carbon cycle. Greenhouse gases act as a blanket, trapping heat in the atmosphere and warming Earth's surface, and providing the conditions for life.

When the sun's energy (or solar radiation) reaches Earth, some of it is reflected back to space by bright surfaces like ice and clouds, and the rest is absorbed by the ocean, land and atmosphere. When heat radiates back from the planet's surface towards space, greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and fluorinated gases such as hydroflurocarbons (HFCs) trap some of this heat. This process makes earth liveable. Without the greenhouse effect, Earth's surface temperature would be around -18°C.[2]

However, human activities are increasing the volume of greenhouse gases in the atmosphere. This intensifies the greenhouse effect, effectively adding another blanket over our planet. Extra heat is trapped in the atmosphere, land and ocean, leading to climate change.

Figure 1: The greenhouse effect



What is anthropogenic global warming?

In 2021, the Intergovernmental Panel on Climate Change (IPCC) stated: 'It is unequivocal that human influence has warmed the atmosphere, ocean and land.[3]

Since the Industrial Revolution, human activities have driven the accumulation of greenhouse gases in the atmosphere. This has led to anthropogenic global warming.

Our use of fossil fuels has been the primary driver of global warming, alongside deforestation and other land use changes. Fossil fuels include coal, oil and gas. Fossil fuels are our biggest source of energy, powering everything from machines to transport to buildings. As of 2022, fossil fuels still represented over 80% of total energy supply globally.[4] When fossil fuels are burnt, large amounts of greenhouse gases are released into the atmosphere, intensifying the greenhouse effect and warming Earth's climate.

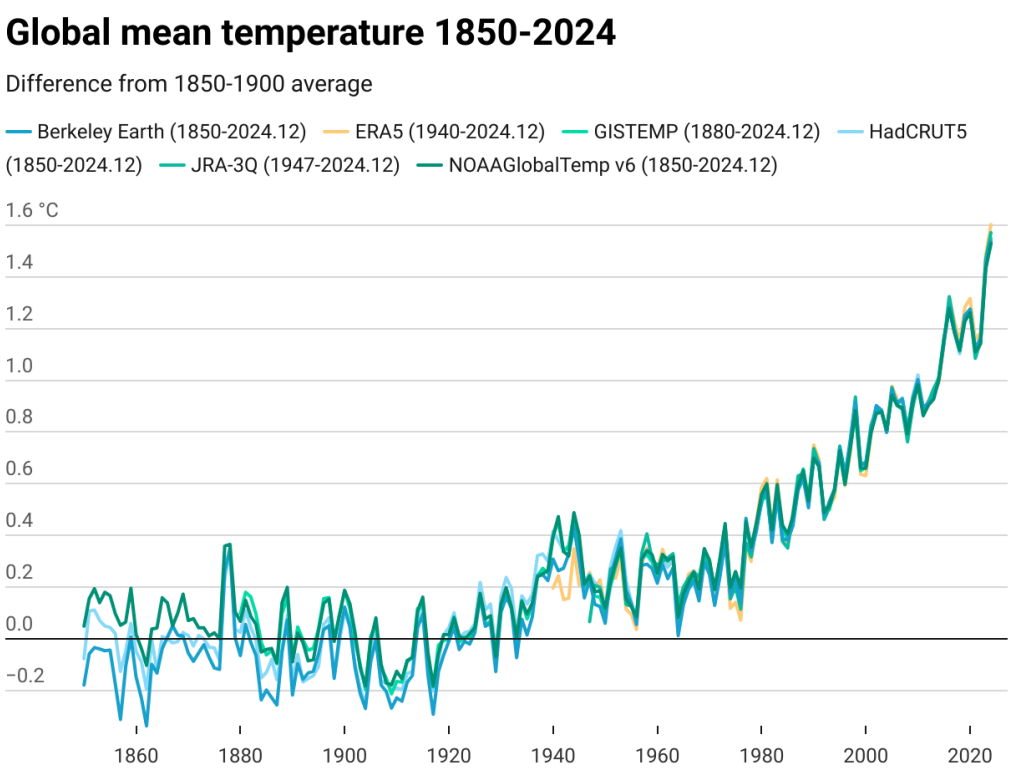
Pre-Industrial Revolution (before 1750): The concentration of carbon dioxide in the atmosphere was around 280 parts per million (ppm)[5] or less.[6] Societies were small and rural, with economies largely reliant on land cultivation (or agrarian).

Since around 1750: Societies have grown bigger, become more connected globally, and rely heavily on industries that use fossil fuels. Since 1751, people have released about 1.5 trillion tonnes of carbon dioxide into the air.[7] Although humans have been adding greenhouse gas emissions to the atmosphere since around 1750, measurement of emissions and temperature increases is mostly from 1850 when more reliable records began. The IPCC's best estimate of human-induced warming is about 1.07°C of global warming between 1850 to 2019 (with a range of 0.8°C to 1.3°C).[3] The sharp rise in global temperatures is shown in Figure 2.

In 2024, the average global temperature was about 1.55°C warmer than it was in the late 1800s, making it the first full year to be more than 1.5°C above the pre-industrial era.[8] In 2025, the amount of carbon dioxide in the atmosphere has exceeded 420 ppm.[9]

While it is well established that global temperatures have increased, the amount of warming cannot be exactly specified due to variable factors in measurement. Therefore measurements, such as temperature increases, are expressed as a range and a best estimate. Scientists can measure how much global warming is caused by CO_2 emissions from human activities, expressed as a range and a best estimate. A degree of uncertainty is inherent in climate science.

Figure 2: Global mean temperature 1850 to 2024[8]



Annual global mean temperature anomalies relative to a pre-industrial (1850–1900) baseline shown from 1850 to 2024

Chart: WMO • Created with Datawrapper

Key takeaways

- Carbon naturally cycles between the atmosphere, ocean, living matter and land.
- Human activities are increasing the concentration of greenhouse gases in the atmosphere, intensifying the greenhouse effect and leading to anthropogenic global warming.

Sources and explanatory notes

[1] National Aeronautics and Space Administration (2011) *The Carbon Cycle*

[2] National Aeronautics and Space Administration(2010) *Global Warming*

[3] Intergovernmental Panel on Climate Change (2021) *Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, P4

[4] International Energy Agency (2024) *Greenhouse Gas Emissions from Energy Data Explorer*

[5] ppm indicates how many molecules of a specific gas are present for every one million molecules of air.

[6] National Oceanic and Atmospheric Administration (2025) *Climate change: atmospheric carbon dioxide*

[7] Ritchie, H. and Roser, M. (2024) *CO_2 emissions*. Our World in Data

[8] World Meteorological Organization (2025) *State of the Global Climate 2024*. Figure license: CC BY-NC-ND 4.0, no changes made

[9] National Oceanic and Atmospheric Administration (2025) *Global Monitoring Laboratory*