Carbon Cycle information pack

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The information in this pack supports the **Carbon Cycle lesson plan** and has been written for the Pod by the Met Office.

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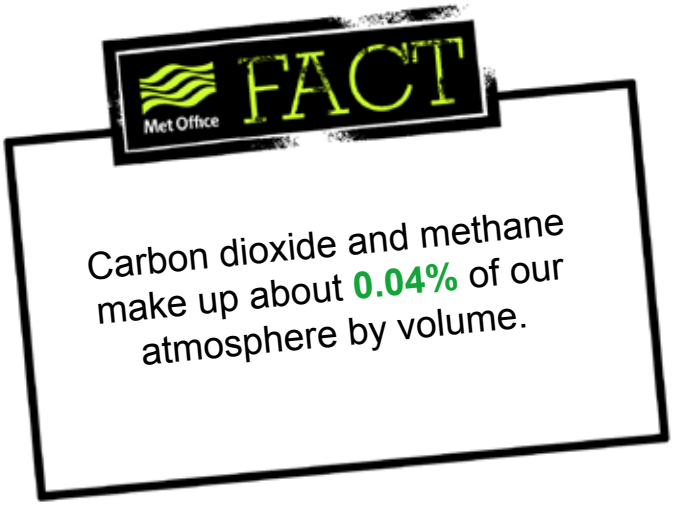
Introduction

Carbon (chemical element C) is one of the most abundant elements in the universe. All known life forms are carbon-based and it amounts to about 18% of a human body.

Carbon dioxide (CO_2) and methane (CH_4) make up about 0.04% of our atmosphere by volume. However, alongside water vapour, nitrous oxide and ozone (collectively called greenhouse gases) they help to keep our planet warm. In fact, without these gases, the Earth's surface would be about 18°C below zero – far too cold for nearly all life to survive.

Greenhouse gases occur naturally, but human activities have directly increased the amount of carbon dioxide, methane and some other gases in our atmosphere. There is overwhelming evidence that this has enhanced the natural greenhouse effect, contributing to the warming we have seen over the last century or so (see the Climate Science information pack for more details on the greenhouse effect).

When studying our climate, scientists draw their evidence from many sources. It is important that they look at all the processes that influence our climate, and one of the most important is the carbon cycle.



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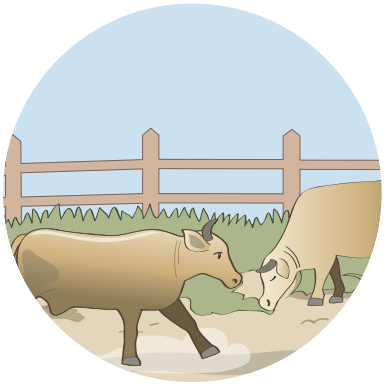
The natural carbon cycle

Sources and sinks

There is a natural carbon cycle in our climate; carbon dioxide (CO_2) and methane (CH_4) enter the atmosphere from a variety of sources:



- When animals breathe, they release carbon dioxide into the atmosphere. Some animals, like cows, also release methane when they burp.
- When plants and animals die, they are broken down by bacteria and fungi. If there is oxygen available in the surroundings, carbon dioxide will be given off during decomposition. If there is no oxygen around, then methane is released instead.
- Carbon dioxide is given off when vegetation burns, for example during forest or healthland fires.
- The surface waters of our oceans contain lots of dissolved carbon dioxide. If the waters warm up, then this can be released back into the atmosphere.
- When volcanoes erupt, they release carbon dioxide into the atmosphere.

These gases are in turn absorbed by a variety of sinks:

- As trees and plants grow, they take in carbon dioxide from the atmosphere. When they die, the vegetation can be turned into peat if the conditions are right. Over millions of years, the peat may be fossilised and form coal.
- Lots of carbon dioxide is absorbed and stored in the cooler surface ocean waters towards the poles.
- There are vast stores of carbon in soil around the world, with soils acting as one of the most important sinks of carbon.
- As rocks are weathered by rain containing a carbon-based acid, the carbon is transformed into bicarbonate ions and transported to the oceans as sediment.
- Some forms of ocean life extract carbon from seawater to form their skeletons or shells. When they die, their remains sink down to the bottom of the ocean and can go on to form carbon-rich rocks like limestone.

This cycle has been delicately balanced for thousands of years. However, observed increases in the level of carbon in the atmosphere can not be explained by natural changes to these sinks and sources.

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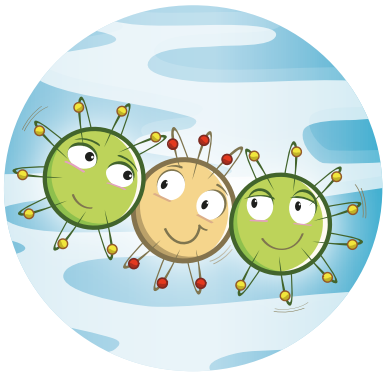
Our influence on the carbon cycle



Molecule for molecule, methane has a stronger greenhouse effect than carbon dioxide, but there is less of it and it only remains in the atmosphere for about a decade. Carbon dioxide on the other hand is much more abundant in the atmosphere and can remain there for 100 years or more, having a greater cumulative effect on our climate. The amount of carbon dioxide in our atmosphere has increased by about 38% since the Industrial Revolution and because it stays for such a long time in our atmosphere, as we emit more it continues to build up.

For every tonne of carbon dioxide released into the atmosphere today, about half will be absorbed by the ocean and land within a year. This means that half is staying in our atmosphere, further contributing to the enhanced greenhouse effect. The absorption helps to mask the true extent of our carbon dioxide emissions.

Scientists say that climate change could have a direct impact on the carbon cycle. As well as sinks becoming less efficient overall, the balance between sources and sinks could be altered in a number of ways as the world continues to warm:

- As the ocean absorbs carbon dioxide it becomes more acidic, reducing the amount of carbon dioxide it can further absorb. This means that more carbon dioxide could stay in the atmosphere, warming the world even further.
- As the temperature of the ocean increases, its capacity to absorb carbon dioxide is reduced. This means that more carbon dioxide could stay in the atmosphere, warming the world even further.
- As temperatures increase, the areas in which trees can grow could extend north to higher latitudes. New trees absorb carbon dioxide, taking it out of the atmosphere.
- As temperatures increase, soils, plants and trees in topical areas could become more heat stressed — potentially releasing the huge amounts of carbon they store and even threatening the future of important areas such as the Amazon rainforest.

These changes could dramatically alter the balance of the carbon cycle, potentially withdrawing the current benefit it offers us. Scientists have included these processes into climate models over the past decade. As we understand more about how they work, the carbon cycle's importance is coming to the forefront of how we look at climate change.