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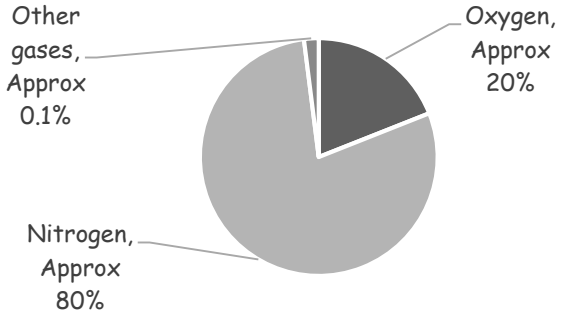
The modern atmosphere

For 200 million years, the proportions of gases in the atmosphere have been the same as they are today:

- about four-fifths (approximately 80 %) nitrogen
- about one-fifth (approximately 20 %) oxygen
- small proportions of various other gases, including CO_2, water vapour and noble gases.



Climate Scientists

Based on peer-reviewed evidence, many scientists believe that **human activities** will cause the **temperature of the Earth's atmosphere to increase** at the surface and that this will result in **global climate change**.

However, it is difficult to model such complex systems as global climate change. This leads to simplified models, speculation and opinions presented in the media that may be based on only parts of the evidence and which may be biased.

The Earth's early atmosphere

It is hard to say exactly how the atmosphere has developed because it has taken 4.6 billion years.

One theory suggests that the first **billion years** of the Earth s existence included **intense volcanic activity**. This released large amounts of **carbon dioxide**, and **nitrogen** and a little **methane** (CH_4) and **ammonia** (NH_3). It may also have released the **water vapour** that later formed the oceans. There was little or no oxygen.

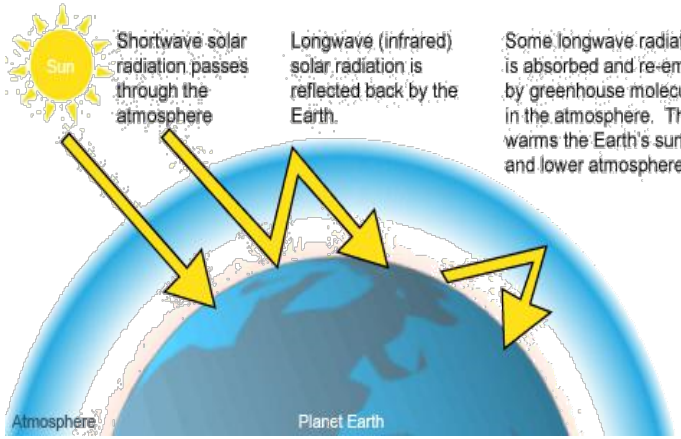
This would make Earth s early atmosphere similar to **Venus** or **Mars** today.

Greenhouse gases

Greenhouse gases include:

Water (H_2O) Carbon dioxide (CO_2) Methane (CH_4)

Without them, the Earth would be too cold to sustain life, but too much of them can cause Earth s atmosphere to heat up and lead to extreme weather.



Greenhouse gases like CO_2 allow **shortwave** radiation to easily pass through the atmosphere

They reach the ground, where they begin to **heat the Earth's surface**.

This transfers the radiation into longer wavelengths.

The CO_2 then absorbs some of the outgoing **longwave** radiation, causing the atmosphere to warm up, and the radiation not to escape.

Too much CO_2 means less longwave radiation escapes, causing global warming.

Changes to the early atmosphere

As Earth cooled, water vapour **condensed** and formed **oceans**.

CO_2 dissolved in the oceans which formed **precipitates** (solids). Some of it was used by sea creatures to make shells, and these later formed **rocks** like **limestone**. **Fossil fuel** formation also trapped CO_2.

2.7 billion years ago, **algae** began producing O_2 by **photosynthesis**, which also reduced the CO_2 in the atmosphere. **Plants** then evolved, followed by O_2 increasing so animals evolved.

Photosynthesis

$$6CO_2 + 6H_2O \xrightarrow{\text{light}} C_6H_{12}O_6 + 6O_2$$

carbon dioxide + water → glucose + oxygen

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Global Climate Change

An increase in average global temperature is a major cause of **climate change**. This may lead to:


Global weather patterns changing (leading to flooding in some areas and drought in others)


Extreme weather events (e.g. hurricanes)


Ice caps and glaciers melting


Sea-levels rising, causing flooding in coastal regions


Desertification

Reduced yields of crops

Human Activities

CO_2 levels are increased by:

- Combustion of fossil fuels
- Deforestation

CH_4 levels are increased by:

- Farming cattle
- Growing rice
- Use of landfill

Know your formulas

CO
Carbon monoxide

CO_2
Carbon dioxide

O_2
oxygen

N_2
nitrogen

NH_3
ammonia

CH_4
methane

Atmospheric pollutants from fuels

Pollutant	Cause	Problem
Carbon dioxide (CO_2)	Complete combustion (sufficient oxygen)	Global warming
Carbon monoxide (CO)	Incomplete combustion (insufficient oxygen)	Toxic gas. Colourless and odourless
Sulfur dioxide (SO_2)	Oxidation of sulfur impurities in fossil fuels	Acid rain & respiratory problems (asthma)
Oxides of nitrogen (NO and NO_2)	Oxidation of nitrogen in air at high temperatures in a vehicle engine	
Carbon particulates (unburnt hydrocarbons)	Burning diesel	Global dimming, health problems

Carbon footprint = the total amount of carbon dioxide and other greenhouse gases emitted over the full life cycle of a product, service or event. One small part of a life cycle assessment.

It includes:

- extracting raw materials
- production
- use
- disposal
- transport at any point in its life cycle

Carbon footprints can be reduced by reducing emission of CO_2 and CH_4 either:

- **Directly**, using green energy sources that don't emit CO_2 e.g. solar power and wind power, instead of burning fossil fuels.

OR

- **Indirectly**, e.g. by insulating a building so it requires less heating, using local materials and products that don't get transported as far.

  This will then require less fossil fuels to be burned for electricity or transport.