

CAUSES OF CLIMATE CHANGE

The Physics of Warming (The Atmosphere)

1. The Earth's Protective Layer

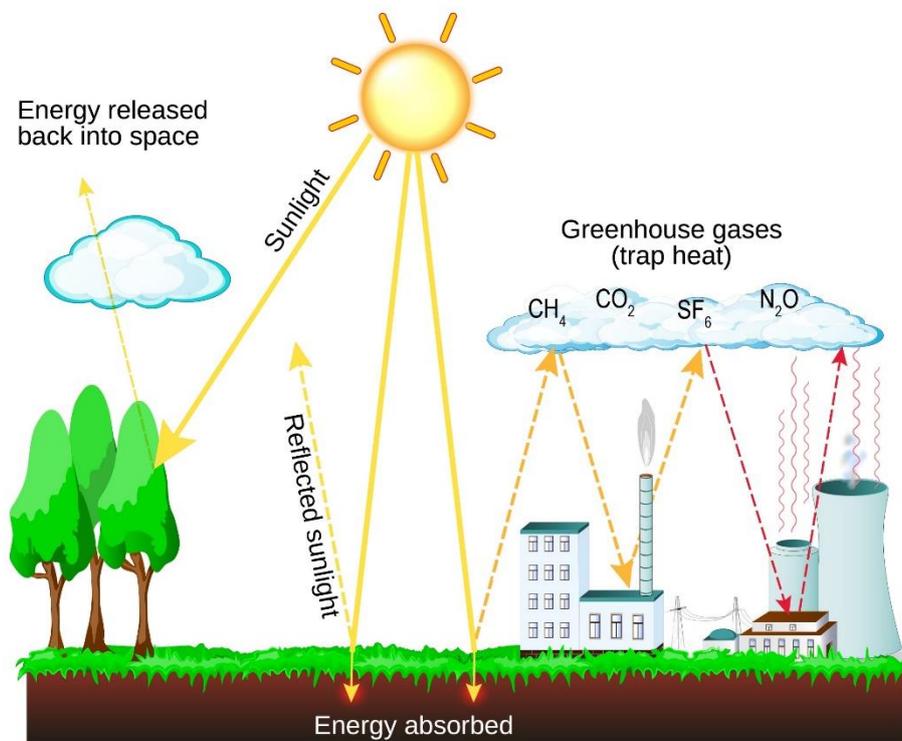
To understand the causes of climate change, we must first look at our **atmosphere**. It is a thin layer of gases surrounding the Earth. Most of this air is Nitrogen (78%) and Oxygen (21%). These gases are "transparent" to heat—they let it pass right through without stopping it.

2. The Role of Trace Gases

The causes of climate change are found in the remaining 1% of the atmosphere. These are called **Greenhouse Gases (GHGs)**. Even though there is a small amount of them, they act like a "thermostat" for the planet.

- **The Process:** Sunlight hits the Earth and warms the ground. The ground then tries to send that heat back into space as infrared radiation.
- **The Trap:** Greenhouse gases "catch" this heat and send it back to the surface. Without this natural effect, Earth would be a frozen desert (about -18°C).

Greenhouse effect



3. Interference

Human

The problem is not the greenhouse effect itself, but that humans have changed the **concentration** of these gases. Since the Industrial Revolution (roughly 1750), we have increased the amount of Carbon Dioxide (CO₂) in the air by **50%**.

Fossil Fuels and the Carbon Cycle

1. What are Fossil Fuels?

The number 1 cause of climate change is the use of **fossil fuels**: coal, oil, and natural gas. These are essentially "stored sunlight." Millions of years ago, plants and tiny sea animals died and were buried under high pressure. They turned into carbon-rich fuel.

2. Unbalancing the Cycle

Normally, carbon moves in a cycle: plants breathe it in, and animals breathe it out. However, when humans dig up fossil fuels and burn them, we are releasing carbon that was trapped underground for **300 million years**.

- **Electricity:** Most global power plants burn coal or gas.
- **Transport:** Almost all cars, planes, and ships use petroleum (oil).
- **Heating:** Many homes burn gas for warmth.

3. Combustion Chemistry

When we burn these fuels (a process called **combustion**), the carbon (C) in the fuel joins with oxygen (CO₂) in the air to create **Carbon Dioxide (CO₂)**. This gas stays in our atmosphere for hundreds, sometimes thousands, of years.

Land Use and Deforestation

1. Trees as Carbon Sinks

Nature has a natural "clean-up" crew: forests. Trees are **Carbon Sinks** because they absorb CO₂ through photosynthesis and store the carbon in their trunks, leaves, and the soil.

2. Why Deforestation is a "Double Blow"

When humans clear forests for farms, roads, or cities, we hurt the climate in two ways:

1. **Loss of Absorption:** There are fewer trees to take CO₂ out of the air.
2. **Release of Carbon:** When trees are burned or rot after being cut down, all the carbon they stored for decades is released back into the atmosphere immediately.

3. Modern Agriculture

Agriculture is a major cause of climate change, but it involves different gases:

- **Methane (CH₄):** Produced by livestock (cows and sheep) during digestion. Methane is **28 times** more powerful at trapping heat than CO₂.
 - **Nitrous Oxide (N₂O):** Released from chemical fertilizers used to grow crops. It is **265 times** more powerful than CO₂.
-

Industrial Processes and Fluorinated Gases

1. Beyond Energy: Chemical Reactions

Not all CO₂ comes from burning fuel. Sometimes, the actual process of making a material creates gas.

- **Cement:** To make cement, we must heat limestone. A chemical reaction occurs that turns the stone into lime and releases CO₂ as a byproduct. The cement industry alone causes about 8% of global emissions.
- **Steel:** To make steel from iron ore, carbon is used to remove oxygen, which releases CO₂.

2. High-Power Man-made Gases

There is a group of gases called **Fluorinated Gases (F-gases)**. These are used in air conditioning, refrigerators, and electronics.

- They do not exist in nature; humans invented them.
 - While there isn't much of them in the air, they are "super-pollutants." Some F-gases are **23,000 times** better at trapping heat than CO₂. A small leak from a refrigerator is a significant cause of warming.
-

Climate Accelerators (Feedback Loops)

One of the most dangerous causes of climate change is that warming **causes more warming**. Scientists call these **Feedback Loops**.

1. The Albedo Effect (Ice vs Water)

"Albedo" describes how much sunlight a surface reflects.

- **White Ice:** Reflects 80% of sunlight back into space.
- **Dark Ocean:** Absorbs 90% of sunlight and gets hot.
- **The Loop:** As the planet warms, ice melts. This reveals dark water. The water absorbs more heat, which melts even more ice.

2. Permafrost Thaw

In the Arctic, the ground is "permafrost" (permanently frozen). This ground holds the remains of ancient plants that haven't rotted yet.

- **The Loop:** As the Arctic warms, the ground thaws. The ancient plants start to rot and release **Methane** and **CO₂**. These gases make the planet warmer, which thaws even more permafrost.

As the air gets warmer, it can hold more water vapor (clouds/humidity). Water vapor is actually a greenhouse gas itself. Warmer air → more evaporation → more heat trapped.

Summary: The Global Emission Pie

If we look at everything humans do, here is why the climate is changing:

1. **Energy & Heat (31%)**
2. **Agriculture & Forestry (24%)**
3. **Industry & Manufacturing (21%)**
4. **Transportation (14%)**
5. **Buildings & Waste (10%)**

Task 1: Cause Awareness (True/False)

1. Oxygen is the main greenhouse gas responsible for warming. ()
2. Burning coal releases carbon that was stored for millions of years. ()
3. The greenhouse effect is completely man-made and did not exist before. ()
4. Methane is a more powerful greenhouse gas than carbon dioxide. ()
5. Deforestation releases carbon into the air and stops carbon absorption. ()
6. Cement production creates CO₂ through a chemical reaction. ()
7. "Albedo" refers to the speed of wind in the atmosphere. ()
8. Permafrost thaw is a feedback loop because it releases more GHGs. ()
9. Agriculture produces both Methane and Nitrous Oxide. ()
10. Fossil fuels include solar, wind, and natural gas. ()

Task 2: Multiple Choice

1. **Which gas has the highest "Global Warming Potential"?**
A. Carbon Dioxide B. Fluorinated Gases C. Nitrogen
2. **What is a "Carbon Sink"?**
A. A factory chimney B. A forest or ocean C. A car engine
3. **Why is dark ocean water a problem for the climate?**
A. It reflects light B. It absorbs heat C. It creates ice
4. **Combustion is the process of:**
A. Planting trees B. Burning fuel C. Recycling plastic

5. Which activity is an "anthropogenic" cause?

A. Volcanic eruption

B. Industrial farming

C. Solar cycles

Task 3: Vocabulary Gap Fill

WORD LIST: *atmosphere, combustion, feedback, fossil, sinks, agriculture, industrial, radiation, emissions, trapped*

1. Burning _____ fuels is the primary cause of modern warming.
2. The _____ of oil in cars produces CO₂.
3. Forests are carbon _____ because they store greenhouse gases.
4. A _____ loop, like melting ice, accelerates global warming.
5. Greenhouse gases stay in the _____ and catch heat.
6. Infrared _____ is sent from the Earth toward space.
7. Modern _____ uses fertilizers that release Nitrous Oxide.
8. Heat is _____ near the Earth's surface by the "blanket" of gases.
9. The _____ Revolution was the starting point of rising CO₂.
10. We must reduce global _____ to stop the temperature rise.

Task 4: Matching Definitions

Term	Definition
1. Anthropogenic	A. A powerful gas from livestock and landfills.
2. Methane	B. Caused by human activity.
3. Albedo	C. The chemical process of making building material.
4. Cement Production	D. How much light a surface reflects.
5. Nitrous Oxide	E. A gas from fertilizers (265x stronger than CO ₂).

Task 5: Sentence Completion

1. The greenhouse effect is like a blanket because _____.
 2. Deforestation is a "double blow" to the climate because _____.
 3. Methane is dangerous because _____.
 4. If the Albedo of the Earth decreases, the planet will _____.
 5. Fossil fuels are "stored sunlight" that we _____.
-

Teacher's Answer Key

Task 1 (T/F): 1.F, 2.T, 3.F, 4.T, 5.T, 6.T, 7.F, 8.T, 9.T, 10.F

Task 2 (MC): 1.B, 2.B, 3.B, 4.B, 5.B

Task 3 (Gap Fill): 1.fossil, 2.combustion, 3.sinks, 4.feedback, 5.atmosphere, 6.radiation, 7.agriculture, 8.trapped, 9.industrial, 10.emissions.

Task 4 (Match): 1-B, 2-A, 3-D, 4-C, 5-E.

Task 5 (Sentences): (Suggested)

- 1...it lets light in but keeps heat from leaving.
- 2...it stops absorption and releases stored carbon.
- 3...it is much stronger at trapping heat than CO₂.
- 4...absorb more heat and get warmer.
- 5...burn for energy today.

"Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or State Education Development Agency Republic of Latvia (VIAA). Neither the European Union nor the granting authority VIAA can be held responsible for them."