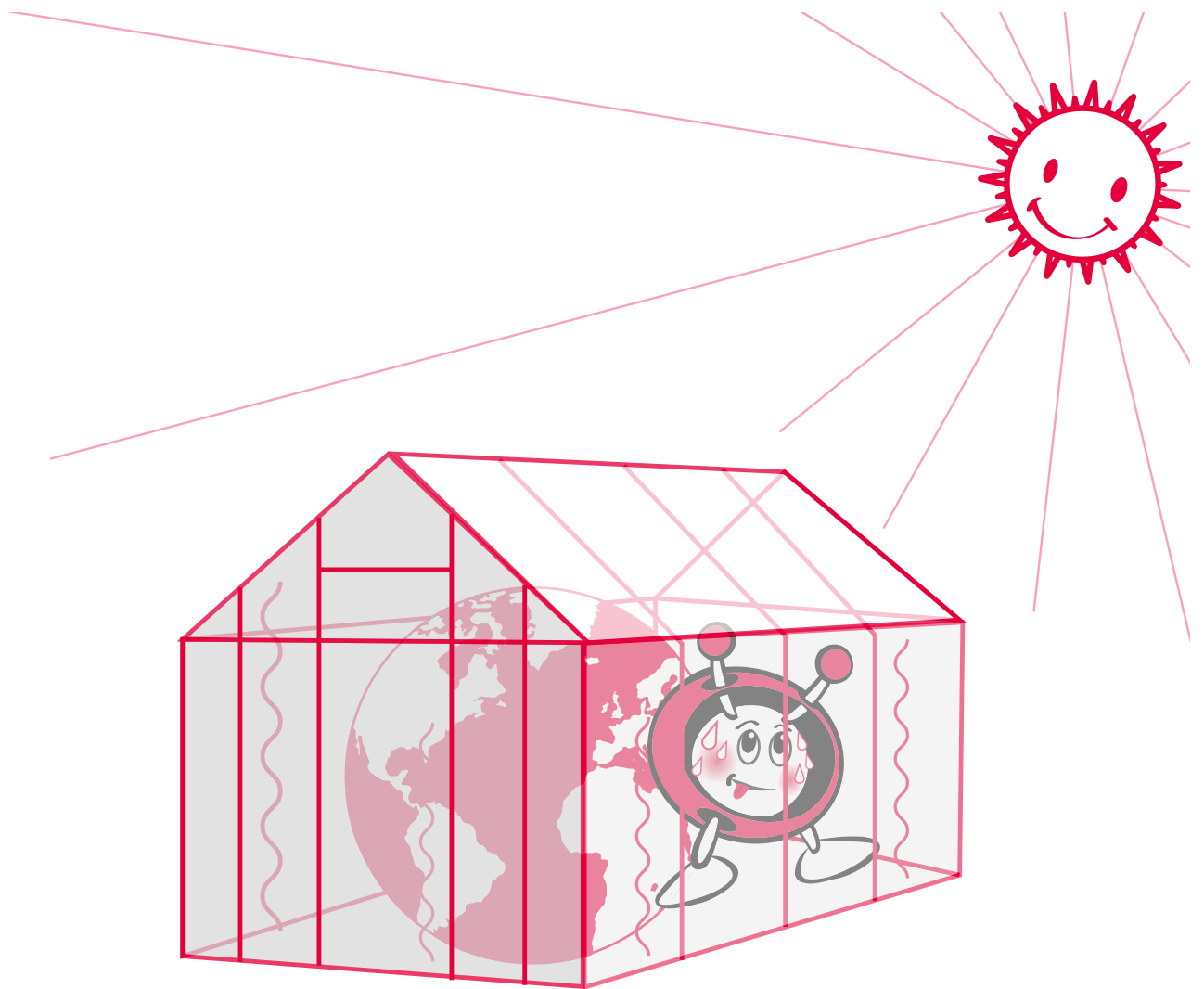


teach with space

→ EARTH UNDER THE LID

Understanding the greenhouse effect



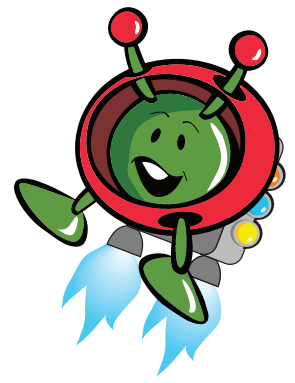


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teach with space – earth under the lid | PR15
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→ EARTH UNDER THE LID

Understanding the greenhouse effect

Fast facts

Subject: Geography, Science

Age range: 8 – 10 years old

Type: student activity

Complexity: easy

Activity time: 60 minutes

Cost per activity: low (0 - 20 euros)

Location: indoors and outdoor

Keywords: Greenhouse effect, Global warming, Geography, Science

Brief description

Our atmosphere and the greenhouse gases that it consists of are what allow the Earth to be a habitable planet. Without them, life as we know it would not exist. Unfortunately, however, the increase in human-produced greenhouse gases is altering the "normal" quantity of these gases in our atmosphere, causing global warming. Pupils will build a model to understand what the greenhouse effect is and analyse a video to discuss the consequences of an increasing amount of greenhouse gases.

Learning objectives

- What the greenhouse effect is.
- What the greenhouse gases are.
- What the positive and negative consequences of the greenhouse effect are.
- That without the greenhouse effect there would not be life as we know it on Earth.
- That the human-induced increase in the greenhouse effect is causing global warming.
- How to perform temperature measurements.



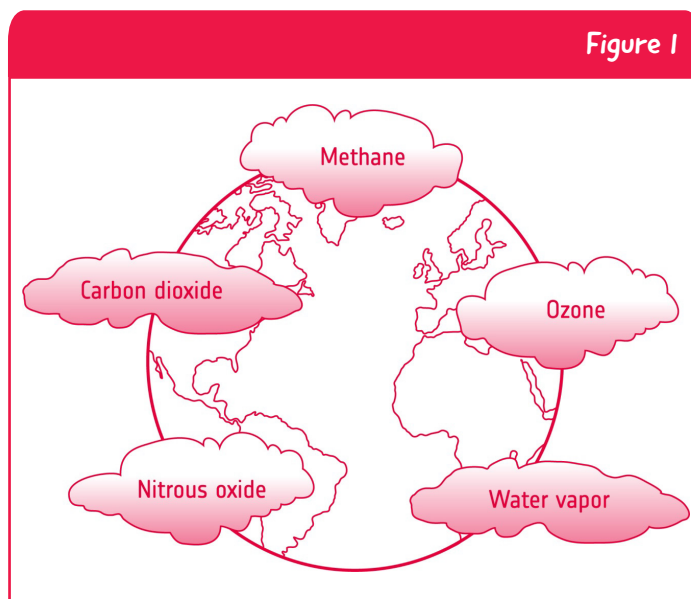
→ Summary of activities

<i>activity</i>	<i>title</i>	<i>description</i>	<i>outcome</i>	<i>requirements</i>	<i>time</i>
1	Why do we need the greenhouse effect on Earth?	Students do an experiment to understand the principle of the greenhouse effect.	Students understand the greenhouse effect and why it is important for life on Earth.	None	40 minutes
2	How do human activities affect greenhouse effect?	Students watch the Paxi video about the greenhouse effect and sort some images according to what they saw in the video.	Students identify the consequences of an increasing amount of carbon dioxide and actions they could take to mitigate global warming.	Completion of activity 1	20 minutes

→ Introduction

The greenhouse effect is what makes our planet habitable, because if we did not have it, the average temperature on Earth would be -18°C . Life as we know it would not be able to exist.

The Earth's atmosphere acts similarly to a greenhouse. Some of the gases that make up the atmosphere are like the glass walls and roof of the greenhouse. During the day, the Sun shines its rays on Earth, warming it. The Earth radiates heat back into the atmosphere during the day and night, which helps to cool the surface. Most of this heat goes back into space, but some of it remains trapped by the greenhouse gases, and stays "inside", which keeps the Earth warm.



↑ Most common greenhouse gases in the Earth's atmosphere.

The Sentinel-5P satellite carries a very special instrument called Tropomi that is able to measure greenhouse gases such as methane and ozone. It also has the capacity to locate where pollutants are being emitted, effectively identifying pollution hotspots. This information is very important to monitor air quality and to understand the chemical processes occurring in the atmosphere and how they are linked to our climate.

Unfortunately, the level of human-produced greenhouse gases in our atmosphere has increased dramatically since the beginning of the industrial revolution in the 18th Century. This means that the greenhouse effect has become too strong. Methane and carbon dioxide are the primary greenhouse gases emitted by humans and the main focus of concern to scientists. The human-induced increase in carbon dioxide happens when we burn fossil fuels like coal and oil to produce energy, and when we cut down and burn trees to make land available for building houses. Methane is also released by the fossil fuel industry, as well as livestock farming and rice agriculture.



↑ Sentinel-5 Precursor – also known as Sentinel-5P – is dedicated to monitoring our atmosphere.

→ Activity 1: Why do we need the greenhouse effect on Earth?

In this activity, students will do an experiment that demonstrates the basics of the greenhouse effect. They will understand how the greenhouse effect works and what effect it has on the temperatures on Earth. They will answer the question “Why do we need the greenhouse effect on Earth?”. Students should conclude that it makes life on Earth possible.

Equipment per group

- 2 transparent jars
- Soil
- Water
- A teaspoon
- 2 thermometers
- Clingfilm
- Rubber bands
- Sticky tape
- If not sunny: lamp that radiates heat

Health and safety

The jars and the lamp must be handled carefully. Students should avoid touching the heat lamp.

Exercise

Start this activity by asking students if they know what the greenhouse effect is. Explain that they will carry out an experiment to simulate what happens on Earth due to the greenhouse effect. After doing the experiment they will answer the question: Why do we need the greenhouse effect on Earth?

Students measure temperatures in two jars with different setups, so it is useful to have groups of two students and each student is responsible for one jar. Students can put their jars on a sunny windowsill or do the experiment outside. If not sunny, consider making use of a bright lamp that radiates heat, e.g. work lamp. Students should place the lamp in a way so that both thermometers are equally illuminated.

For detailed instructions about the experiment setup, see the student guide. To perform this experiment successfully, consider the following points:

- Place the thermometers so that they do not touch the soil.
- The jars should be covered airtight. Otherwise, measurements are less accurate.

Before the students start the measurements, you can discuss with them their expectations by asking if and how the temperatures will be changing after putting the glasses in the sun or under the lamp.

You can also run this activity as a demonstration. For that we suggest to make use of two transparent aquariums or boxes instead of the jars. You can have students taking the measurements and note them on the board or a poster.



	Jar without cover	Jar with cover
Start temperature	24.6°C	24.4°C
Measurement 1 after 5 min	26.3°C	29.6°C
Measurement 2 after 10 min	29.2°C	37.0°C
Measurement 3 after 15 min	29.0°C	36.9°C

↑ Example results from tests (your results may vary!)

Discussion

The temperature of the air in the jar covered with the clingfilm is higher than in the open jar. The clingfilm lets the heat in but blocks part of it inside the jar, so the air inside heats up. This is a very simple simulation of the greenhouse effect on Earth. The jar covered with clingfilm represents Earth with an atmosphere and the jar without a cover represents Earth without an atmosphere.

Talk about the greenhouse effect in our atmosphere and the gases that act in a similar way to the cover of the jar. The thinner the atmosphere of a planet is, the weaker the greenhouse effect will be. You can give students the example of Mars. The existing atmosphere is so thin that it cannot retain energy from the sun and because of that there are extreme temperature contrasts between day and night. Older students can investigate the greenhouse effect on other planets.

The students learn from this experiment that the greenhouse gases in Earth's atmosphere trap the heat emitted from the ground and thus warm the atmosphere. If the Earth didn't have an atmosphere, life as we know on Earth would be almost impossible as the average temperature would be several degrees Celsius below zero.



→ Activity 2: How do human activities affect greenhouse effect?

In this activity, students see the Paxi video by ESA Education about the greenhouse effect. They will sort images taken from the video according to their appearance in the video. The video serves as an introduction to discuss how human activities are increasing the amount of greenhouse gases on Earth's atmosphere and its consequences.

Equipment

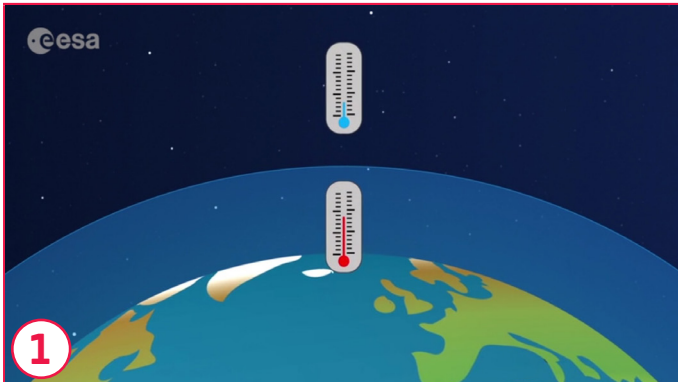
- Laptop or other device to play video, and projector
- Worksheet
- Scissors
- Glue

Exercise

Together in class, watch the Paxi video about the greenhouse effect (see Links section). After watching the video, distribute the images in the Annex. The images are screenshots from the video. Students cut out the images and put them in the order of appearance. In the end, when they are sure about their results, they glue the images in the boxes 1-6 and describe below what they see on the image.

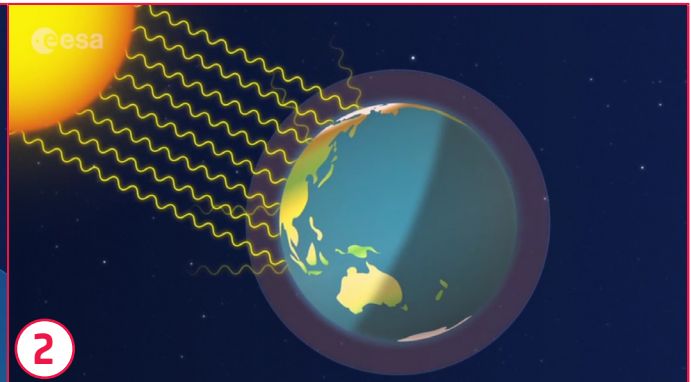
Discuss the outcomes with the students. They should understand that the increase in human-produced greenhouse gases is altering the 'normal' quantity of these gases in our atmosphere, causing global warming. Discuss with the students possible actions that we can take to help reduce the amount of carbon dioxide in Earth's atmosphere (recycling; saving electricity; using the carless; planting trees, etc).





1

The atmosphere contains the air we breathe and makes life on Earth possible. It also protects us from the cold in space to keep us warm.



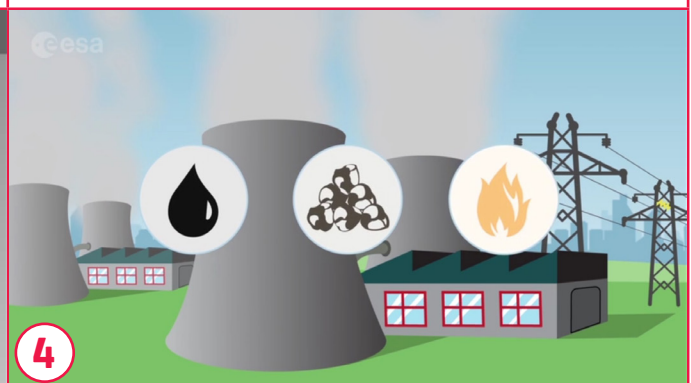
2

The greenhouse gases in the atmosphere work like a greenhouse, keeping some of the Sun's heat on Earth.



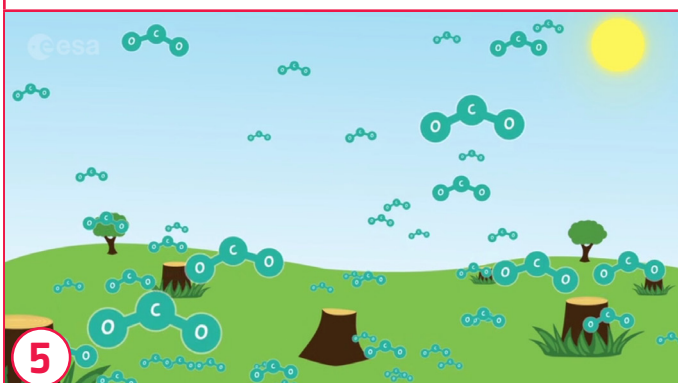
3

Scientists are worried because the greenhouse effect is becoming too strong. The Earth is getting warmer too fast.



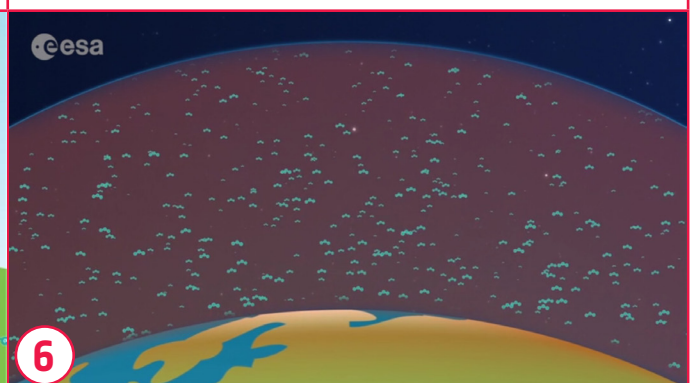
4

Burning oil, coal and natural gas, and other human activities, are responsible for an increasing amount of greenhouse gases.



5

Cutting down trees makes carbon dioxide, an important greenhouse gas, increase a lot because trees normally absorb carbon dioxide and take it out of the atmosphere.



6

The increasing amount of carbon dioxide, the greenhouse gas, makes the greenhouse effect stronger, which leads to increasing temperatures on Earth.



→ EARTH UNDER THE LID

Understanding the greenhouse effect

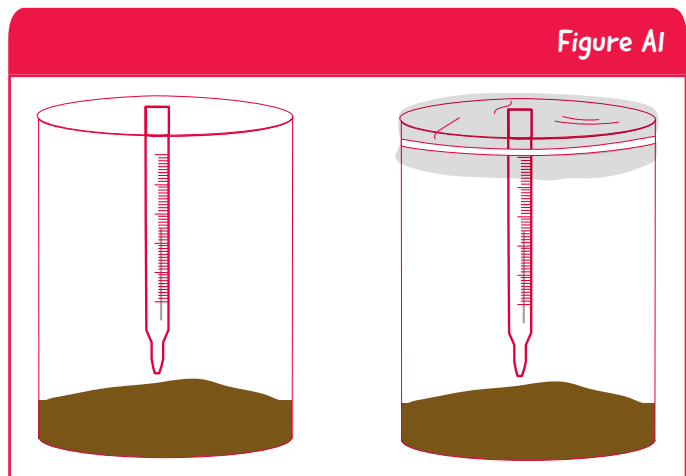
→ Activity 1: Why do we need the greenhouse effect on Earth?

In this activity, you will do an experiment to understand how the greenhouse effect works and what effect it has on the temperatures on Earth. You will answer the question:

Why do we need the greenhouse effect on Earth?

Equipment

- 2 transparent jars
- Soil
- Water
- A teaspoon
- 2 thermometers
- Clingfilm
- Rubber bands
- Sticky tape



↑ Experiment set-up.

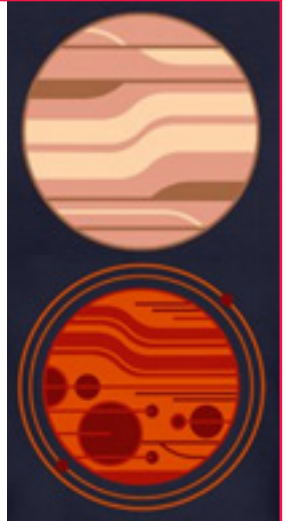
Exercise

1. Fill each jar with some soil so that the bottom is covered. Add 2-3 drops of water.
2. Place the thermometers in the jars so that they do not touch the soil. Use the sticky tape to hang the thermometer to the jars.
3. Cover the top of one jar with the clingfilm. Use the rubber band to hold the clingfilm in place.
4. Leave the second jar open.
5. Record the initial temperature of each thermometer.
6. Put both jars in the sun (or below a strong, warm light).

Did you know?

For a really strong greenhouse effect we should look at Venus. Venus is similar to Earth in terms of mass and size, but the Venusian atmosphere is mainly made up of carbon dioxide – a greenhouse gas. Thanks to this, the surface temperature on Venus is 460°C . This is hot enough to melt zinc. Scientists are exploring Venus' atmosphere as it could help us to understand the greenhouse effect on Earth.

A complete contrast to Venus is Mars. The Red Planet displays hardly any greenhouse effect. Mars does have some atmospheric carbon dioxide, but almost no atmosphere! The existing atmosphere is so thin that it cannot retain energy from the Sun. There are, therefore, extreme temperature contrasts between day and night and sunlight or shade.



Results

Write down the initial temperatures. Then read the temperatures in the jars every five minutes and fill out the table with your measurements.

	Jar without cover	Jar with cover
Start temperature		
Measurement 1 after 5 min		
Measurement 2 after 10 min		
Measurement 3 after 15 min		

Discussion

- Did one of the thermometers in your experiment show a higher temperature? If so, explain why.

- One of the jars (1) represents Earth with an atmosphere; the other jar (2), Earth without an atmosphere. Identify which jar stands for which situation and circle the correct answer.

Jar without cover: (1) (2)
 Jar with cover: (1) (2)

- Complete the following sentence: If the Earth did not have an atmosphere, then...

- Explain why we need the greenhouse effect on Earth.



→ Activity 2: How do human activities affect greenhouse effect?

In this activity, you will follow Paxi, the European Space Agency (ESA) Education mascot, and explore with him what the greenhouse effect is and how human activities can change this natural effect.

Equipment

- Scissors
- Glue

Exercise

1. Cut out the images from the video provided by your teacher.
2. Put them in the right order in the boxes number 1 to 6.
3. When you are sure you have the right order, glue them into the table.
4. Describe what happens in each image.
5. Write down three possible actions that you can take to help reducing the amount of carbon dioxide on Earth's atmosphere.

Action 1: _____







Action 2: _____

Action 3: _____

Did you know?

ESA started the Climate Change Initiative (CCI) to understand how and why the climate is changing. The scientists work together with experts from all over Europe to analyse satellite images and measurements taken on Earth. The CCI Greenhouse Gases team is analysing measurements covering the years since 2002. With this information, scientists can better monitor the greenhouse gases in Earth's atmosphere.



	
1 _____ _____	2 _____ _____
	
3 _____ _____	4 _____ _____
	
5 _____ _____	6 _____ _____

→ LINKS

ESA resources

Paxi animation about the greenhouse effect

esa.int/esatv/Videos/2018/05/Paxi_-_The_Greenhouse_Effect

ESA classroom resources

esa.int/Education/Classroom_resources

ESA Kids

esa.int/esaKIDSen

ESA space projects

ESA's Climate Change Initiative

<http://cci.esa.int/>

Sentinel-5P mission

esa.int/Our_Activities/Observing_the_Earth/Copernicus/Sentinel-5P

Extra information

Video from ESA Climate Change Initiative about the carbon cycle

esa.int/spaceinvideos/Videos/2018/02/Carbon_Cycle



→ ANNEX

