

Greenhouse Gases (GHGs)

Trace gases in our atmosphere act like the glass in a greenhouse. These trace gases trap much of the heat from the sun close to earth at night.

These gases are called Greenhouse Gases (GHGs) and they help keep our world's temperatures in balance. Without these GHGs, our planet might be like a freezer.

But too much of a good thing can turn into a bad thing! Unfortunately, we are putting too many GHGs into our atmosphere and these gases are trapping too much heat.

So these GHGs are rather important. We need to understand how they affect our world's temperature and where they come from in the first place. This backgrounder dives into the details of some of the key gases floating about above our heads.

The GHG Club

There are many GHGs in the atmosphere that affect our climate There are four main ones and a bunch of smaller ones.

Water vapour

If you have gone into a bathroom after someone has showered and felt the dampness on your skin – the humidity in the air – then you have been surrounded by water vapour, the most common GHG. Water vapour causes about 65% of the natural greenhouse effect.

When water in rivers, lakes and oceans gets warm it evaporates. This means it becomes water vapour and rises into the atmosphere. Water vapour helps to keep the sun's energy that is absorbed by land and water from escaping back into space. It can form clouds that reflect some of the sun's energy back into space. The clouds also act like a blanket and trap heat close to earth.

When water vapour in the atmosphere cools, it condenses into rain and snow and then falls back to earth. That is how water cycles back into rivers, lakes and oceans.

Carbon dioxide

If you have smelled the fumes from a car or snowmobile, you have got a nose full of carbon dioxide (CO_2) at the same time. Smoke from a woodstove or a forest fire also contains a lot of carbon dioxide as it heads up to the atmosphere. Humans and animals breathe out carbon dioxide. Trees and plants breathe in carbon dioxide when they make their food through a process called photosynthesis. The same trees and plants then give off carbon dioxide when they breathe, and when they die and decompose.

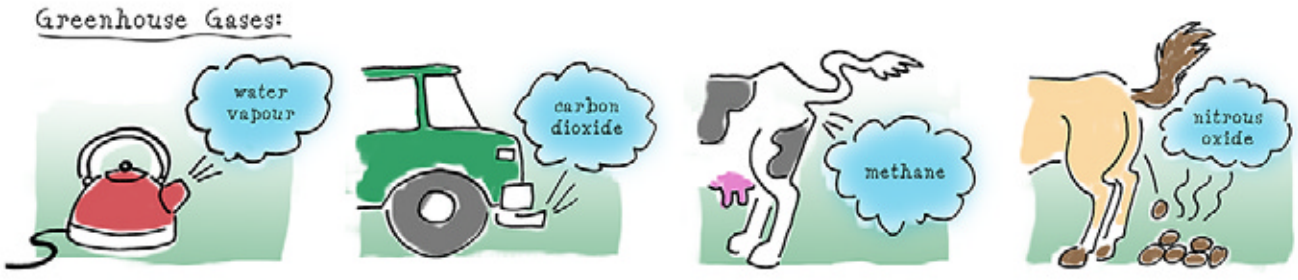
Carbon dioxide is the second most common GHG. Carbon dioxide makes up about 25% of the natural greenhouse effect.

Methane

If you have seen a herd of bison, muskox or cows grazing, then you have seen methane, the third most common GHG on the list, being produced!

Methane is created when organic matter decomposes (rots) without any oxygen present ("anaerobic" decomposition).

Animals like cows, bison, muskox, sheep, goats and camels are called "ruminants" (they have multiple stomachs to digest food). In the large fore-stomach of these animals, their food is broken down by little microbes. This creates gas – methane – and it is released the way most of us release stomach gas! Humans also produce methane, but not nearly as much as ruminants.



Another source of methane is natural gas, a fossil fuel we often use to heat homes and run some types of vehicles. Natural gas is also formed by the decay of organic matter (plants and animals) but these plants decomposed thousands of years ago! Natural gas is found 3,000 to 15,000 feet below the earth's surface.

If you put your food scraps in a sealed bucket and let them rot, you will release methane into the air when you finally open the lid. When our leftovers from dinner, grass clippings from our lawns or even waste paper from last year's school assignments decompose in the community dump, they will release methane (unless the waste is turned frequently so that oxygen is mixed with the organic waste as it breaks down).

Nitrous oxide

If you have horses or other livestock, pile a lot of horse manure up and let it rot. You will produce nitrous oxide (N_2O), the next most important GHG.

When farmers use chemical fertilizers that are nitrogen-based, nitrous oxide can be released as the fertilizer breaks down. Nitrous oxide is also stored in soil. When farmers turn the soil to prepare the land for crops, nitrous oxide is often released.

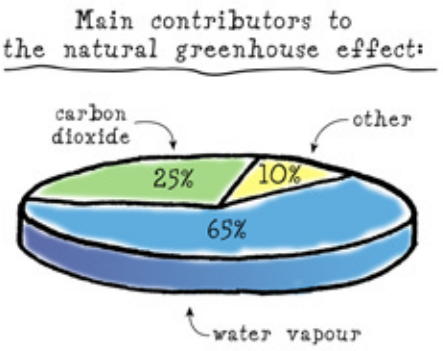
Nitrous oxide is also created when ammonia is being made by catalytic converters in automobiles.

The other bunch

Other GHGs, such as chlorofluorocarbons (CFCs) and hydrofluorocarbons (HFCs), do not make up as much of our atmosphere as the main four, but they still play a role.

Size Isn't Everything

As we've learned, GHGs are found naturally in the atmosphere. But GHGs make up a very tiny part of it. Water vapour can make up to 4% of the atmosphere in humid parts of the world. However, the other three GHGs all together still make up less than 0.1% of the atmosphere.



Although they are tiny in volume, these GHGs have a big influence on our climate. They help keep some of the sun's heat in so the earth doesn't turn into an icebox. However, because humans have been adding more GHGs

to the atmosphere, more heat is being trapped close to earth and our greenhouse is getting too hot for comfort.

Although water vapour is the biggest member of the GHG club, it isn't much of a concern. That's because water vapour only occurs naturally. The amount of water in the world is limited and cycles between the atmosphere, oceans, rivers and lakes. There is little we can do to change the amount of water vapour in the atmosphere.

On the other hand, carbon dioxide, methane and nitrous oxide are produced both naturally and by humans. These three GHGs have been in the atmosphere naturally pretty much since we have had an atmosphere.

But more recently, humans have been pumping a lot of these GHGs into the atmosphere by doing things like burning oil, gas and coal, farming on a large-scale, letting waste rot in dumps, and so on. These human produced GHGs are changing the natural balance of things. Although the climate has always changed, over the history of the earth, things are warming up this time because humans have been putting too many GHGs into the atmosphere.

Not All GHGs Are the Same

Although carbon dioxide, methane and nitrous oxide are all part of the GHG club, they are as different as squirrels, caribou and bears. To understand the differences, there are three main things to consider:

- How long do they stay in the atmosphere?
- How much heat can they trap?
- How did they get into the atmosphere?

Comparing the GHG club members

GHG	How long does it hang out in the atmosphere?	Global warming potential over 100 years (when compared to CO_2)	What percentage of climate change over the past century did it cause?	Where does it come from?
Carbon Dioxide (CO_2)	50–200 years	1	54.9	Burning of oil and gas (for heat, transportation, industry), cement manufacturing, deforestation and other land uses. Also occurs naturally through photosynthesis, volcanoes, forest fires.
Methane	12 years	23	18.0%	Oil and gas production, coal mining, rice paddies, dams, landfills. Occurs naturally as things decompose and from livestock digestion.
Nitrous Oxide	120 years	296	5.6%	Burning of oil, gas, coal, and wood, fertilizers, coal mining. Also occurs naturally.
Other GHGs	Varies	Varies	20.3%	Refrigerator coolants, industrial pollution.

According to the table "Comparing the GHG club members," methane has 23 times more "global warming potential" than carbon dioxide. What does that mean?!

Just as different types of blankets keep different amounts of heat in, different GHGs work differently. Some keep more heat in than others. And some last longer than others!

If you think of one bit of carbon dioxide as being one blanket, then one bit of methane would be equal to 23 blankets of the same type. Nitrous oxide would be one big stack of 296 blankets!

So when we're talking about GHGs we are putting into the atmosphere, we need to consider the warming potential of each GHG, not just how much we are pumping up, up and away.

Cycling Carbon

Carbon dioxide is an important GHG to focus on because there is so much of it in our atmosphere and humans put a lot of it there!

As you've read, there are a number of things that add carbon dioxide to the atmosphere naturally. There are also natural processes that take these gases out of the atmosphere. This adding and subtracting of carbon dioxide is what has helped to keep things in balance for thousands of years.

Sinks Are For Cleaning Up

Areas that absorb and hold onto lots carbon dioxide are called carbon "sinks". There are three main carbon sinks in the world:

Sink #1: Oceans

Mostly, the oceans take up carbon dioxide by absorbing and dissolving it into the water, the way that carbon dioxide is stored in a bottled soft drink! Much of this ends up in the deep ocean. Almost as much carbon dioxide is released again from the ocean surface into the atmosphere through bursting bubbles and other processes.

Like trees in the forest, little organisms floating in the world's oceans also use carbon dioxide to make their food (through photosynthesis). These organisms are called phytoplankton.

In recent decades, these processes have helped the oceans to absorb a bit more carbon than they released each year. So the oceans are currently socking away a lot of carbon.

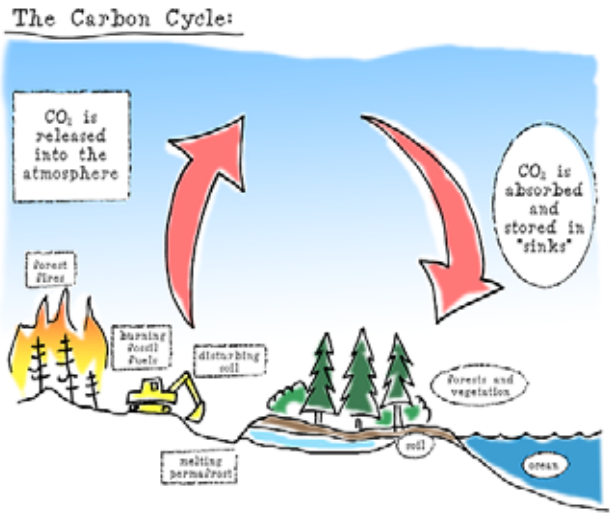
Sink #2: Soil

Dirt is more than just dirt. Pick up a handful and you will be holding billions of micro organisms and bacteria. These microscopic things nibble on plants and trees as the vegetation dies and break the plants and trees down into carbon and nutrients. This carbon is stored in the ground everywhere in the world, even in permafrost areas. But when we disturb the soil, we speed up the release of the stored carbon. Logging and farming are two large-scale ways we disturb the soil. Melting permafrost will also release carbon dioxide.

Sink #3: Forests and Vegetation

Plants and trees breathe in and absorb carbon dioxide as they turn the sun's energy into food through a process called photosynthesis. When trees and plants die or burn in fires, they release this absorbed carbon to the soil and to the atmosphere.

Plants also breathe out some carbon dioxide when they are living. On the whole, however, plants and trees absorb more carbon dioxide than they release to the atmosphere when they are growing. This means they help to take some of the extra carbon out of the atmosphere.



However, as the world warms up, more forest fires are predicted and this could release large amounts of carbon into the atmosphere.

A carbon "sink" can become a carbon "source". For example, a growing forest is a carbon sink as it absorbs more carbon than it releases. But when it burns, it becomes a carbon "source" as it releases lots of carbon into the atmosphere.

Not so permanent?

Permafrost – that layer of frozen ground that is found in most of the North – might not be so permanent in some areas.

The temperature of permafrost in much of the north is usually only a few degrees below zero. So if climate change warms up the north by 5° in the next 50–100 years, there is going to be a whole lot of melting going on!

This will cause a lot of changes. For example, our roads and buildings will shift as some of the layers of permafrost in the ground under them melt. Shorelines will become less solid as permafrost melts so ocean waves and river currents will erode more land by the water's edge.

Permafrost also keeps carbon dioxide and methane locked in the ground. Of all carbon stored in the soil around the world, about one third of it is frozen in the permafrost! This makes permafrost areas very important carbon reservoirs.

But when the permafrost starts to melt, more GHGs could be released into the atmosphere. and the world's greenhouse could warm up even more. This would cause still more permafrost to melt, and then even more GHGs could go into the atmosphere. This chain reaction is called positive feedback.

Where to From Here?

So we know that the atmosphere is like a big greenhouse that keeps the world's temperatures, on average, just right for humans, animals and plants. To keep that greenhouse working well, we need the right balance of greenhouse gases (GHGs) in the atmosphere.

However, humans have been adding a lot of GHGs to the atmosphere as we take oil and gas out of the ground and burn it for energy. We also put GHGs into the atmosphere when we disturb the soil, cut down trees, or pile-up our garbage.

This is having a lot of impact on our climate and causing temperatures to rise. To read more about the effects of climate change, look for the backgrounders in this series on

impacts. To see what you and others can do to help reduce GHGs in the atmosphere, check out the backgrounders on solutions to climate change.

Key Points

- Water vapour is the main Greenhouse Gas (GHG). It is produced naturally, as part of the world's water cycle.
- Carbon dioxide is the second most important GHG. It is produced naturally, and by humans. Methane and Nitrous Oxide are also important GHGs. They occur naturally and are produced by humans.
- Areas that absorb and hold onto lots of carbon are called "sinks". There are three main carbon sinks in the world: oceans; soil; and forests and vegetation.
- Permafrost stores a lot of carbon and methane. Some of these GHGs might be released when permafrost melts.

Want to Know More?

Check out these websites to learn more about greenhouse gases:

- **Energy Information Administration:** http://www.eia.doe.gov/oiaf/1605/ggccebro/chapter1.html – Good information on greenhouse gases, primarily in the U.S.
- **Environment Canada:** http://www.ec.gc.ca/pdb/ghg/gases_e.cfm – A basic overview of greenhouse gases with lots of links to more in-depth information.
- **U.S. Environmental Protection Agency:** http://yosemite.epa.gov/oar/globalwarming.nsf/content/emissions.html – Here you can get into as much detail about these gases as you want.
- **Your Planet Earth:** http://www.yourplanet.org/terms/details.php3?term=Greenhouse+Gases – Good overview, with links for more follow-up.