Emissions

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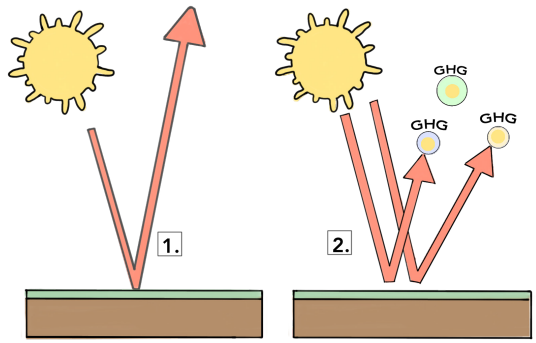
Greenhouse Gases (GHGs) are molecules which contribute to the greenhouse effect in our atmosphere. When the sun's light hits the earth, it would normally reflect back into space; however GHGs are able to absorb some of this light and 'trap' extra solar energy in Earth's atmosphere (1). Through increased emissions of GHGs, such as carbon dioxide from the burning of fossil fuels, the amount of heat trapped in the atmosphere also increases, creating what we know as global warming (2).

The most significant contributors to climate change among GHGs are carbon dioxide, methane, nitrous oxide and fluorinated gases (3). Each of these gases are emitted from multiple sources, and have a different impact on global temperatures (3). In Canada, the largest producers of GHGs are the transportation and the oil and gas industries, accounting for, respectively, 24.3% and 27.3% of total emissions in 2018 (4).

Carbon Dioxide CO_2

Accounting for more than 75% of GHG emissions on the planet, carbon dioxide (CO_2) is the largest contributor to human made climate change (3,5). CO_2 is released into the atmosphere through many different processes, including the burning of fossil fuels, setting of concrete, as well as the destruction of forests and other ecological systems, among many other practices (3). CO_2 is a naturally common compound that plays an important as part of Earth's carbon cycle (2). This being said, problems with CO_2 arise when forms of concentrated carbon, such as fossil fuels, are burned and released in large quantities into the air, causing the level of CO_2 in the atmosphere to be unnaturally high (2,4).



Illustrated by Chloe Graham

Figure 1. *(1) Under normal circumstances, when light from the sun reflects off the Earth, it is usually reflected back into space. (2) However, GHGs are able to absorb some of the normally reflected light, "trapping" extra solar energy in the Earth's atmosphere which contributes to global warming.*

CO_2 in the atmosphere is also increased through the destruction of the environment (e.g. forest fires) Trees contain lots of carbon, in many forms, and when they burn the carbon is released as CO_2 (6). In addition to releasing more CO_2 into the air, practices like deforestation also decrease the planet's ability to store CO_2 (7).

As a result of human activity, the level of CO_2 in the atmosphere has skyrocketed to over 400 parts per million (ppm), 100 ppm greater than the levels before the Industrial Revolution, and is continuing to rise (8).

As CO_2 is the most abundant GHG in our atmosphere, scientists use it as a way to evaluate the warming effect of all other major GHGs.

Definition

Global warming potential (GWP) is a way to measure a GHG's ability to trap heat within the atmosphere, as compared to CO_2, which has a GWP of 1 (9).

This allows us to compare the intensity of different GHGs and emphasizes that even GHGs released in smaller quantities have significant effects on the planet.

Nitrous Oxide N_2O

With a GWP of 298, nitrous oxide is a strong GHG – almost 300 times more effective at trapping heat in the atmosphere than CO_2 (9). In addition to its effects as a GHG, nitrous oxide in the atmosphere also contributes to the reduction of the ozone layer, a layer of molecules high in the atmosphere that protects us from harmful UV radiation (10).

Nitrous oxide is produced through processes such as fossil fuel burning, the production of materials such as nylon and explosives, and through the largest source, agriculture (11,8).

Nitrous oxide in agriculture comes from the nitrogen used in commercial and consumer fertilizers (12). When these fertilizers are added to soil, around half of the nitrogen is taken up by the crops, helping them grow, while the rest is used by microbes in the soil and converted into nitrous oxide (13). With an ever-rising global population, there is an increased demand for fertilizers in order to meet food supply requirements. Since many fertilizers produce nitrous oxide, increased agriculture using current methods will increase GHG emissions and encourage ozone depletion (11,13,12).

Methane CH_4

Accounting for 15% of global GHG emissions, methane has a GWP of 36, meaning it is 36 times better at trapping heat than CO_2 (9,12). In Canada, methane is mainly produced through the oil and gas sector, with 98% of our methane production originating from the ventilation of storage tanks (14). In addition, studies have shown that methane production at many natural gas production sites may be extremely under reported, which means that its overall impact on the climate crisis may be underestimated as well (14). Methane can also be linked to the agriculture industry, specifically livestock. For example, one estimate suggests that, in one year, a single cow can create the same amount of methane as the emissions from a medium-sized car driving 20,000 kilometers (15). Other than human-related sources, large amounts of methane can potentially be released through temperature warming that causes permafrost soils to thaw (15). As the ground heats up, huge amounts of CO_2 and methane that have been frozen in the soil will be freed and released into the atmosphere, which will worsen the warming of our Earth (16).

Fluorinated Gases

While ozone-depleting chlorofluorocarbons have been almost completely phased out in Canada under the Montreal Protocol, their replacements - fluorinated carbons - are still a strong GHG in our atmosphere (17). Fluorinated gases are synthetic compounds which are used in many household and industrial applications, such as air conditioning, production of aluminum and magnesium, and manufacturing of products such as electronics, appliances, and carpet (5).

These compounds can have varying GWPs that can be as high as 23,500 in the case of sulfur hexafluoride, making it one of the most potent GHGs (5,17). Due to the severe effects of fluorinated gases, all 197 member nations of the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer agreed to the Kigali Amendment in 2016, adding fluorinated gases to the controlled substances list (17). Each nation also agreed to gradually reduce their production of these gasses between 2019 and 2024 (18).

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