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Emission of Green House Gases

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Summary

Carbon dioxide, Methane, Nitrous oxide, industrial gases are most important greenhouse gases present in the atmosphere. Carbon dioxide is the single most important anthropogenic greenhouse gas in the atmosphere and its globally averaged concentration in 2023 was 420 ppm. It emitted through volcanic eruptions, burning of hydrocarbon fuels, production of mineral products, metals and chemicals, burning of crop residues and land use changes. Methane is emitted from anthropogenic sources, such as ruminants, fossil fuel exploitation, livestock, waste and landfills, rice cultivation and biomass burning. Its globally averaged concentration in 2023 was 1934 ppb. Nitrous oxide is emitted into the atmosphere from natural sources and anthropogenic sources including oceans, soils, biomass burning, fertilizer use, and various industrial processes. Its globally averaged concentration in 2023 was 336.9 ppb. SF_6 is an extremely potent long-lived greenhouse and it is produced by the chemical industry.

Introduction:

Greenhouse gases occur naturally and allow us to survive on Earth by warming air near Earth' s surface. These are gaseous compounds that can emit ultraviolet radiation within a certain thermal infrared range. Greenhouse gases retain high temperatures in the lower atmosphere, thus allowing less heat to escape back to space. This subsequently results in the greenhouse effect and global warming. The greenhouse effect is a natural process that warms the Earth' s surface to a temperature above which it would be without the atmosphere. The intensity of the greenhouse effect depends largely on the temperature of the atmosphere, and on the presence of greenhouse gases in the atmosphere. Greenhouse gases are vital for supporting a habitable temperature for the Earth. Common greenhouse gases present in the atmosphere include water vapor,

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chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3). Although water vapor is arguably the most abundant greenhouse gas naturally present in the atmosphere, CO_2 is the most emitted greenhouse gas. Human activities are now increasing the amount of greenhouse gases in the atmosphere, which leads to changes in climate. These changes are affecting many human activities, including agriculture.

Green House

A greenhouse is a building with glass walls and a glass roof. A greenhouse captures heat from the Sun during the day which keeps plants inside the greenhouse warm. In the daytime, wall trap sunshine' s into the greenhouse, and warms the plants and air inside. At nighttime, it's colder outside, but the greenhouse stays pretty warm inside, because the glass walls of the greenhouse trap the Sun's heat.

Green House Effect

There are many components in the atmosphere act as greenhouse gases. These gases allow sunlight (shortwave radiation) to freely pass through the Earth' s atmosphere and heat the land and oceans. The warmed Earth releases this heat in the form of infrared light (longwave radiation), invisible to human eyes. Some of the infrared light released by the Earth passes through the atmosphere back into space. However, greenhouse gases will not let all the infrared light pass through the atmosphere. They absorb some and radiate it back down to the Earth. This phenomenon, called the greenhouse effect, is naturally occurring and keeps the Earth' s surface warm. It is vital to our survival on Earth. Without the greenhouse effect, the Earth' s average surface temperature would be about 60°F colder.

Green House Gases

Several gases in the atmosphere can absorb heat. These greenhouse gases are produced both by natural processes and by human activities. The primary ones are: Carbon dioxide, Methane, Nitrous oxide, industrial gases, including hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

Terms to differentiate the impacts of different greenhouse gases

Global Warming Potential (GWP)

It is an index that represents the global warming impact of a greenhouse gas relative to carbon dioxide. GWP represents the combined effect of how long the gas remains in the atmosphere and its relative effectiveness in absorbing outgoing infrared heat.

Carbon dioxide-equivalents (CO_2-eq)

These are units that represent the relative impact of a given gas on atmospheric warming, based on the gas' GWP. For

example, a ton of methane can be expressed as 21 tons of CO_2-eq, and a ton of nitrous oxide can be expressed as 310 tons of CO_2-eq.

Concentration ((ppb) and Lifetime of Green House Gases in the Atmosphere

Parameters	Carbon Dioxide	Methane	Nitrous Oxide	Chlorofluorocarbon
Chemical Formula	CO_2	CH_4	N_2O	CFC
Average Conc. 100-year age	290000	900	270	0
Current Concentration	380000	1774	319	3-5
Global Warming Potential	1	21	298	4750-10900

(IPCC, 2007)

The latest analysis of observations from the WMO Global Atmosphere Watch (GAW) in situ observational network shows that the globally averaged surface concentrations for carbon dioxide (CO_2) is 420.0±0.1 ppm, methane (CH_4) 1934±2 ppb and nitrous oxide (N_2O) 336.9±0.1 ppb.

Sources of Green House Gases Emission

Carbon Dioxide

It is naturally present in the atmosphere as part of the Earth's carbon cycle (the natural circulation of carbon among the atmosphere, oceans, soil, plants, and animals). Human activities are altering the carbon cycle both by adding more CO_2 to the atmosphere and by influencing the ability of natural sinks, like forests and soils, to remove and store CO_2 from the atmosphere. The level of carbon dioxide in Earth' s atmosphere has been rising consistently for decades and traps extra heat near Earth's surface, causing temperatures to rise.

Sources of Emission

- The oceans, soil, plants, animals and volcanoes are natural sources of CO_2 emissions.
- Burning of hydrocarbon fuels (*i.e.* wood, coal, natural gas, gasoline, and oil). Coal is the largest fossil fuel source of carbon dioxide emissions.
- The combustion of fossil fuels such as gasoline and diesel in transportation sector.
- The combustion of fossil fuels to generate electricity and heat.
- The production of mineral products such as cement and metals such as iron and steel.
- The production of chemicals and petrochemical products.
- During the process of cellular respiration and process of decomposition.
- Weathering of carbonate rocks.
- Burning of crop residues.
- Land use changes are when the natural environment is converted into areas for

human use like agricultural land or settlements. E.g. Deforestation.

- The largest natural source of emissions is ocean-atmosphere exchange. The oceans contain dissolved CO_2, which is released into the air at the sea surface but they also absorb it.
- Carbon dioxide is a byproduct of the chemical reaction that plants and animals use to produce the energy they need *i.e.* plant respiration. soil respiration.
- Plant roots, bacteria, fungi and soil animals use respiration to create the energy they need to survive but this also produces carbon dioxide.
- Decomposers that work underground breaking down organic matter (like dead trees, leaves and animals) are also included in this.

Methane

It is a greenhouse gas with a global warming power estimated to be 21– 36 times more than CO_2 over the last 100 years, thereby ranking it as the second most anthropogenic greenhouse gas emitted into the atmosphere.

- Domestic livestock such as cattle, swine, sheep, and goats produce CH_4 through their normal digestive process. This process is called enteric fermentation.
- Stored or managed animal manure in lagoons or holding tanks releases CH_4.
- Land use and land management activities.
- During the production, processing, storage, transmission, distribution, and use of natural gas.
- The production, refinement, transportation, and storage of crude oil.
- Coal mining is also a source of CH_4 emissions.
- Methane is generated in landfills as waste decomposes and in the treatment of wastewater.
- Emitting CH_4 from bacteria that decompose organic materials in the absence of oxygen.
- Reservoirs and ponds with high organic matter and low oxygen levels also produce methane through the microbial breakdown of organic matter.
- The energy sector includes coal mining, natural gas systems, oil systems as well as fixed and mobile combustion systems, is the largest source of methane emissions into the atmosphere.
- Waste generated during the combustion, conservation and management of biomass.

Nitrous Oxide

Besides carbon dioxide and methane, nitrous oxide is another problematic greenhouse gas with a high potential of causing greenhouse effect.

- Emitted from waste water containing organic-based nitrogen materials, such as materials from human or animal waste.
- Application of synthetic nitrogen fertilizers to soils and forest lands.
- Land use and land management activities e.g. forest and grassland fires.
- Burning of fuels depends on the type of fuel and combustion technology, maintenance, and operating practices.
- The production of chemicals such as nitric acid, which is used to make synthetic commercial fertilizer.
- The production of adipic acid, which is used to make fibers, like nylon, and other synthetic products.
- Treatment of domestic wastewater during nitrification and denitrification of the nitrogen present, usually in the form of urea, ammonia, and proteins.
- It emitted naturally through nitrogen cycle, which is the natural circulation of nitrogen among the atmosphere, plants, animals, and microorganisms that live in soil and water. .

Fluorinated Gases

These are the most potent and longest lasting type of greenhouse gases emitted by human activities. Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3) are four main categories of fluorinated gases. chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs).

- Hydrofluorocarbons are used as refrigerants, aerosol propellants, foam blowing agents, solvents, and fire retardants in products used by homes, businesses and industry. The major emissions source of these compounds is their use as refrigerants.
- HFCs are released into the atmosphere during manufacturing processes and through leaks, servicing, and disposal of equipment in which they are used.
- Perfluorocarbons are used in the manufacturing of semiconductors.
- Sulfur hexafluoride is used as an insulating gas in electrical transmission equipment, including circuit breakers.

Conclusion

Greenhouse gases are maintaining Earth' s climate by trapping and emitting heat in the atmosphere through the natural greenhouse effect. Without this effect, Earth would be too cold or hot to support life. Many human activities like burning of fossil fuels,

deforestation, industrial processes, and agricultural practices are significantly increasing the concentration of greenhouse gases in the atmosphere. This enhanced greenhouse effect is leading to global warming and changes in climate patterns. Each greenhouse gas differs in its source, longevity, and global warming potential, but together they contribute to rising global temperatures, disrupted ecosystems, and threats to human health, agriculture, and water resources. Understanding the sources and impacts of greenhouse gases is crucial for developing effective strategies to reduce emissions and mitigate climate change.

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