The greenhouse effect – causes and impacts essay sample

Environment, Earth

The greenhouse effect refers to circumstances where the short wavelengths of visible light from the sun pass through a transparent medium and are absorbed, but the longer wavelengths of the infrared re-radiation from the heated objects are unable to pass through that medium. The trapping of the long wavelength radiation leads to more heating and a higher resultant temperature. Besides the heating of an automobile by sunlight through the windshield and the namesake example of heating the greenhouse by sunlight passing through sealed, transparent windows, the greenhouse effect has been widely used to describe the trapping of excess heat by the rising concentration of carbon dioxide in the atmosphere. The carbon dioxide strongly absorbs infrared and does not allow as much of it to escape into space.

A major part of the efficiency of the heating of an actual greenhouse is the trapping of the air so that the energy is not lost by convection. Keeping the hot air from escaping out the top is part of the practical “ greenhouse effect”, but it is common usage to refer to the infrared trapping as the “ greenhouse effect” in atmospheric applications where the air trapping is not applicable.

Solar radiation at the frequencies of visible light largely passes through the atmosphere to warm the planetary surface, which then emits this energy at the lower frequencies of infrared thermal radiation. Infrared radiation is absorbed by greenhouse gases, which in turn re-radiate much of the energy to the surface and lower atmosphere. The mechanism is named after the effect of solar radiation passing through glass and warming a greenhouse,

but the way it retains heat is fundamentally different as a greenhouse works by reducing airflow, isolating the warm air inside the structure so that heat is not lost by convection. Earth’s natural greenhouse effect makes life as we know it possible. However, human activities, primarily the burning of fossil fuels and clearing of forests, have intensified the natural greenhouse effect, causing global warming

Greenhouse Effect Example

Bright sunlight will effectively warm a car on a cold, clear day by the greenhouse effect. The longer infrared wavelengths radiated by sun-warmed objects do not pass readily through the glass. The entrapment of this energy warms the interior of the vehicle. The trapping of the hot air so that it cannot rise and lose the energy by convection also plays a major role. Short wavelengths of visible light are readily transmitted through the transparent windshield. Shorter wavelengths of ultraviolet light are largely blocked by glass since they have greater quantum energies which have absorption mechanisms in the glass. Even though one may be uncomfortably warm with bright sunlight streaming through, one will not be sunburned.

MECHANISM

The Earth receives energy from the Sun in the form UV, visible, and near IR radiation, most of which passes through the atmosphere without being absorbed. Of the total amount of energy available at the top of the atmosphere (TOA), about 50% is absorbed at the Earth’s surface. Because it is warm, the surface radiates far IR thermal radiation that consists of

wavelengths that are predominantly much longer than the wavelengths that were absorbed (the overlap between the incident solar spectrum and the terrestrial thermal spectrum is small enough to be neglected for most purposes). Most of this thermal radiation is absorbed by the atmosphere and re-radiated both upwards and downwards; that radiated downwards is absorbed by the Earth’s surface. This trapping of long-wavelength thermal radiation leads to a higher equilibrium temperature. This highly simplified picture of the basic mechanism needs to be qualified in a number of ways, none of which affect the fundamental process.

The incoming radiation from the Sun is mostly in the form of visible light and nearby wavelengths, largely in the range 0. 2–4 μm, corresponding to the Sun’s radiative temperature of 6, 000 K. Almost half the radiation is in the form of “ visible” light, which our eyes are adapted to use. About 50% of the Sun’s energy is absorbed at the Earth’s surface and the rest is reflected or absorbed by the atmosphere. The reflection of light back into space—largely by clouds—does not much affect the basic mechanism; this light, effectively, is lost to the system. The absorbed energy warms the surface. Simple presentations of the greenhouse effect, such as the idealized greenhouse model, show this heat being lost as thermal radiation. The reality is more complex: the atmosphere near the surface is largely opaque to thermal radiation (with important exceptions for “ window” bands), and most heat loss from the surface is by sensible heat and latent heat transport. Radiative energy losses become increasingly important higher in the

atmosphere largely because of the decreasing concentration of water vapour, an important greenhouse gas.

It is more realistic to think of the greenhouse effect as applying to a “ surface” in the mid-troposphere, which is effectively coupled to the surface by a lapse rate. The simple picture assumes a steady state. In the real world there is the diurnal cycle as well as seasonal cycles and weather. Solar heating only applies during daytime. During the night, the atmosphere cools somewhat, but not greatly, because its emissivity is low, and during the day the atmosphere warms. Diurnal temperature changes decrease with height in the atmosphere. Within the region where radiative effects are important the description given by the idealized greenhouse model becomes realistic: The surface of the Earth, warmed to a temperature around 255 K, radiates long-wavelength, infrared heat in the range 4–100 μm. At these wavelengths, greenhouse gases that were largely transparent to incoming solar radiation are more absorbent.

Each layer of atmosphere with greenhouses gases absorbs some of the heat being radiated upwards from lower layers. It re-radiates in all directions, both upwards and downwards; in equilibrium (by definition) the same amount as it has absorbed. This results in more warmth below. Increasing the concentration of the gases increases the amount of absorption and re-radiation, and thereby further warms the layers and ultimately the surface below. Greenhouse gases—including most diatomic gases with two different atoms (such as carbon monoxide, CO) and all gases with three or more atoms—are able to absorb and emit infrared radiation. Though more

than 99% of the dry atmosphere is IR transparent (because the main constituents—N2, O2, and Ar—are not able to directly absorb or emit infrared radiation), intermolecular collisions cause the energy absorbed and emitted by the greenhouse gases to be shared with the other, non-IR-active, gases.

The existence of the greenhouse effect was argued for by Joseph Fourier in 1824. The argument and the evidence was further strengthened by Claude Pouillet in 1827 and 1838, and reasoned from experimental observations by John Tyndall in 1859, and more fully quantified by Svante Arrhenius in 1896.

WHAT ARE GREENHOUSE GASES?

Many chemical compounds present in Earth’s atmosphere behave as ‘ greenhouse gases’. These are gases which allow direct sunlight (relative shortwave energy) to reach the Earth’s surface unimpeded. As the shortwave energy (that in the visible and ultraviolet portion of the spectra) heats the surface, longer-wave (infrared) energy (heat) is reradiated to the atmosphere. Greenhouse gases absorb this energy, thereby allowing less heat to escape back to space, and ‘ trapping’ it in the lower atmosphere. Many greenhouse gases occur naturally in the atmosphere, such as carbon dioxide, methane, water vapor, and nitrous oxide, while others are synthetic. Those that are man-made include the chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs) and Perfluorocarbons (PFCs), as well as sulfur hexafluoride (SF6). Atmospheric concentrations of both the natural and man-made gases have been rising over the last few centuries due to the industrial revolution. As the global population has increased and our reliance on fossil

fuels (such as coal, oil and natural gas) has been firmly solidified, so emissions of these gases have risen. While gases such as carbon dioxide occur naturally in the atmosphere, through our interference with the carbon cycle (through burning forest lands, or mining and burning coal), we artificially move carbon from solid storage to its gaseous state, thereby increasing atmospheric concentrations.

Water Vapour is the most abundant greenhouse gas in the atmosphere, which is why it is addressed here first. However, changes in its concentration is also considered to be a result of climate feedbacks related to the warming of the atmosphere rather than a direct result of industrialization. The feedback loop in which water is involved is critically important to projecting future climate change, but as yet is still fairly poorly measured and understood.

Carbon Dioxide

The natural production and absorption of carbon dioxide (CO_2) is achieved through the terrestrial biosphere and the ocean. However, humankind has altered the natural carbon cycle by burning coal, oil, natural gas and wood and since the industrial revolution began in the mid 1700s, each of these activities has increased in scale and distribution. Carbon dioxide was the first greenhouse gas demonstrated to be increasing in atmospheric concentration with the first conclusive measurements being made in the last half of the 20th century. Prior to the industrial revolution, concentrations were fairly stable at 280ppm.

Methane is an extremely effective absorber of radiation, though its atmospheric concentration is less than CO2 and its lifetime in the atmosphere is brief (10-12 years), compared to some other greenhouse gases (such as CO2, N2O, CFCs). Methane(CH4) has both natural and anthropogenic sources. It is released as part of the biological processes in low oxygen environments, such as in swamplands or in rice production (at the roots of the plants). Over the last 50 years, human activities such as growing rice, raising cattle, using natural gas and mining coal have added to the atmospheric concentration of methane.

Tropospheric Ozone

Ultraviolet radiation and oxygen interact to form ozone in the stratosphere. Existing in a broad band, commonly called the ‘ ozone layer’, a small fraction of this ozone naturally descends to the surface of the Earth. However, during the 20th century, this tropospheric ozone has been supplemented by ozone created by human processes. The exhaust emissions from automobiles and pollution from factories (as well as burning vegetation) leads to greater concentrations of carbon and nitrogen molecules in the lower atmosphere which, when it they are acted on by sunlight, produce ozone. Consequently, ozone has higher concentrations in and around cities than in sparsely populated areas, though there is some transport of ozone downwind of major urban areas.

Nitrous Oxide

Concentrations of nitrous oxide also began to rise at the beginning of the industrial revolution and is understood to be produced by microbial

processes in soil and water, including those reactions which occur in fertilizer containing nitrogen. Increasing use of these fertilizers has been made over the last century

Chlorofluorocarbons (CFCs) have no natural source, but were entirely synthesized for such diverse uses as refrigerants, aerosol propellants and cleaning solvents. Their creation was in 1928 and since then concentrations of CFCs in the atmosphere have been rising. Due to the discovery that they are able to destroy stratospheric ozone, a global effort to halt their production was undertaken and was extremely successful.

Carbon Monoxide and other reactive gases

Carbon monoxide (CO) is not considered a direct greenhouse gas, mostly because it does not absorb terrestrial thermal IR energy strongly enough. However, CO is able to modulate the production of methane and tropospheric ozone. The Northern Hemisphere contains about twice as much CO as the Southern Hemisphere because as much as half of the global burden of CO is derived from human activity, which is predominantly located in the NH.

Volatile Organic Compounds (VOCs) also have a small direct impact as greenhouse gases, as well being involved in chemical processes which modulate ozone production. VOCs include non-methane hydrocarbons (NMHC), and oxygenated NMHCs (eg. alcohols and organic acids), and their largest source is natural emissions from vegetation. However, there are some anthropogenic sources such as vehicle emissions, fuel production and

biomass burning. Though measurement of VOCs is extremely difficult, it is expected that most anthropogenic emissions of these compounds have increased in recent decades.

These are sketches of the graphs produced in the IPCC 2007 report of the increase in key greenhouse gases. They make clear that most of the increase of the last thousand years has occurred in the past 200 years. The radiative forcing of these gases is related to their concentration.

Role in climate change

Climate change will have a substantial impact on ecosystems and on human activities. Locally, the rise in temperatures has already triggered phenomena such as permafrost thaw and lower water levels in the Great Lakes and the St. Lawrence River. Experts also predict that global warming will result in more extreme weather, including more severe snow storms, heat waves, and droughts. Heat waves are particularly worrisome in the Montréal area. In 2003, there were 69 heat-related deaths, and that number is expected to increase by 80% by 2050. The average annual number of extremely hot days in Montréal will rise from 13 to 55 during that same period.

Kyoto Protocol

The first United Nations environmental conference was held in Stockholm in 1972. Twenty years later, the Earth Summit in Rio put environmental and development issues in the spotlight. The United Nations Framework Convention on Climate Change (UNFCCC), which was signed at that Summit, aimed to stabilize atmospheric GHG concentrations at a level that would

prevent any climate change. Convention signatories met in Kyoto In December 1997, and agreed upon a protocol aimed at reducing GHG emissions in 38 industrialized countries, between 2008 and 2012, to levels averaging 5. 2% lower than in 1990. Implementation of this Protocol required ratification by 55 of the signing countries that accounted for at least 55% of the GHG emissions of industrialized countries. The Kyoto Protocol took effect on February 16, 2005, which was 90 days after Russia’s ratification on November 16, 2004. THE GREENHOUSE EFFECT – CAUSES

The main reason for greenhouse effect is the emission of gases like nitrous-oxide, carbon-di-oxide, methane, ozone and water vapour. The causes of these emissions have been listed below.

I. Deforestation

One of the major reasons for the greenhouse effect is deforestation. With the increase in population, more and more forests are being cut to provide accommodation and other amenities to people. This has led to an increase in the amount of carbon di-oxide in the atmosphere. Add to this, burning of forests, for the purpose of deforestation, and we know why the carbon di-oxide has increased to such enormous levels.

II. Burning of Fossil Fuels

We all know that burning of fossil fuels, like petroleum and oil, wood and gas results in release of pollutants into the atmosphere. With time, the consumption of fossil fuels, be it for industrial purposes or consumer purposes, has increased and with it, the pollution levels in the world.

III. Electrical Appliances

Electrical appliances are amongst the major contributors to the greenhouse effect. Refrigerators, air conditioners or some other electric appliances emit gases, known as Chlorofluorocarbons (CFCs), which have added to the greenhouse effect.

IV. Industries

Most of the industries today add to the pollution levels and in turn, lead to the greenhouse effect. Aerosol cans, some foaming agents used in the packaging industry, fire extinguisher chemicals and cleaners used in the electronic industry contribute to this. Even some processes of the cement manufacturing industries can be counted amongst the culprits.

V. Automobiles

Automobiles, whether they run on petrol or diesel, create pollution and release harmful gases into the atmosphere. These gases, in turn, create the greenhouse effect in the atmosphere. The forever-increasing use of automobiles has only added to the problem.

VI. Population Growth

The high rate of population growth has been indirectly responsible for the greenhouse effect. With the increase in the number of people, the need for things like accommodation, clothes, cars, ACs, etc has increased. The result is more industries, more cars, more deforestation, and so on. The ultimate consequence is greenhouse effect.

THE GREENHOUSE EFFECT – IMPACT

The greenhouse effect‘ s impact is to make life as we know it possible on planet Earth, but the greenhouse effect may also bring an end to life as we know it. The greenhouse effect refers to the trapping of heat by certain gases in the atmosphere, including carbon dioxide and methane. Although these gases occur in only trace amounts, they block significant amounts of heat from escaping out into space, thus keeping the Earth warm enough for us to survive. Humans have been adding greenhouse gases in excessive amounts to the atmosphere ever since the Industrial Revolution, which is enhancing the greenhouse effect and resulting in what is now known as “ global warming.” This increase in greenhouse gases has the potential to cause catastrophic problems for Earth and its inhabitants.

I. The Biggest Problem – Sea Level Rise

The most dangerous aspect of global warming is probably sea level rise. In fact, the world’s oceans have already risen 4-8 inches. That may not sound like much, but it has been enough to cause the erosion of some islands. People have had to relocate to higher ground on low-lying islands in the South Pacific and off the coast of India as a result of the effects of global warming. Further sea level rise could cause great suffering. In Bangladesh alone, there are 15 million people living within 1 meter of sea level and another 8 million in a similar circumstance in India. Inhabited land could be inundated if sea levels continue to rise. Much of the world’s best farmland is low-lying, as are many of the world’s largest cities. Even a very modest rise in sea levels would have an enormous impact on millions of people around the world.

II. Droughts and Floods

Ironically, changes in the climate due to excess greenhouse gases are causing both increased drought and increased flooding. Violent storm activity will increase as temperatures rise and more water evaporates from the oceans. This includes more powerful hurricanes, pacific typhoons, and an increased frequency of severe localized storms and tornadoes. As these storms often result in flooding and property damage, insurance premiums are skyrocketing in coastal areas as insurance companies struggle to cover escalating costs. Warming also causes faster evaporation on land. Many dry areas, including the American West, Southern Africa, and Australia are experiencing more severe droughts. The amount of land on the Earth suffering from drought conditions has doubled since 1970. This has occurred even as total global rainfall has increased by an estimated 10%!

III. The Human Price of Climate Change

Drought is driving current increases in food prices around the world, in combination with increased use of grains for fuel. Globally, the number of malnourished people decreased up until the late 1990s. Now that number is increasing. Disease carriers will expand their territory, either by moving to higher elevations in mountainous areas or by expanding their territory further from the equator. This expansion will expose millions of humans to the often deadly infectious diseases that these animals transmit. 150, 000 annual deaths worldwide have been tied to climate change already, according to a 2005 World Health Organization report. Climate related

deaths are expected to double in 25 years. Industrialized countries may be sheltered from the current impacts of climate change, but others are not. Heat waves and droughts are responsible for these deaths, as well as floods and more powerful storms linked to climate change.

IV. Approaching a Slippery Slope

Global temperatures have risen about . 8° Celsius or 1. 4° Fahrenheit already. As a result of this increase, the vast arctic tundra is melting, releasing enormous volumes of both carbon dioxide and methane into the atmosphere. This creates the possibility of a self-reinforcing loop of climate change: as more carbon dioxide and methane are released from the arctic tundra, the greenhouse effect will be further enhanced. The world’s oceans are losing their ability to absorb carbon because of rising water temperatures, according to accumulating evidence. This is significant because the world’s oceans hold 50 times more carbon than do the world’s forests and grasslands. The decreasing capacity of the Earth’s carbon sinks to absorb carbon could further increase the likelihood of runaway climate change.

V. Rapid Climate Shifts

Scientists are becoming convinced that past cycles of climate change on the Earth have been anything but slow and incremental, ever since the idea that the Earth may warm over time as a result of human-created climate change has reached the public consciousness. Climate change happens suddenly and violently. Research indicates that the Earth’s climate exists in a stable

state for many thousands of years. Then, pressure for change builds from increases or decreases in carbon levels as well as changes in solar radiation. At some point, the Earth reaches a tipping point where global climate systems and ocean currents are radically altered over the course of only a few years, or even months. Once that threshold is crossed, the Earth's climate goes through a period of dramatic disequilibrium, finally settling down in a new stable state that is very different from the previous one. There is no turning back if we cross the threshold and reach a tipping point. Weather patterns all over the world may be disrupted, ending life as we know it.

GREENHOUSE GASES AND GLOBAL WARMING

There are numerous environmental issues which threaten the very existence of life on Earth, and global warming is perhaps the most severe of them all. Many people assume that the greenhouse effect and global warming are one and the same thing, which is technically incorrect. The high concentration of greenhouses gases, such as carbon dioxide and methane, in the atmosphere is one of the numerous causes of global warming. That being said, the relationship between greenhouse gases and temperature rise can be best defined as cause and effect relationship.

Difference between Greenhouse Gases and Global Warming

The term ' greenhouse gases' refers to various gases in the Earth's atmosphere, which are typically characterized by their ability to absorb infrared radiations coming from the Sun. The entire process wherein the

Sun’s infrared radiations are trapped within the atmosphere by these greenhouse gases is referred to as the ‘ greenhouse effect’. Greenhouse gases list includes gases such as carbon dioxide, carbon monoxide, methane, chlorofluorocarbons, etc., – some of which stay in the atmosphere for several years and contribute to the greenhouse effect on the planet. The atmospheric concentration of these gases is one of the main causes of the greenhouse effect. Global warming, on the other hand, refers to an incessant rise in global average temperature triggered by various natural and anthropogenic causes – greenhouse gases being one of them.

Relationship between Greenhouse Gases and Global Warming

Even though we say that the atmospheric concentration of greenhouse gases has a key role to play when it comes to global warming, these gases are not the only causes of this hazardous phenomenon. Other than the atmospheric concentration of these gases, global warming causes also include numerous other natural occurrences and anthropogenic activities. For instance, solar radiations (a natural cause) and deforestation (an anthropogenic cause) are not at all related to greenhouse gases, but they do play a crucial role in causing the global temperature to rise. On the contrary, if it were not for these greenhouse gases, the Earth would have been freezing cold and devoid of any of the present life forms which inhabit it. The fact that these gases play a crucial role in maintaining the necessary balance in global temperature makes their presence on the planet very important.

If greenhouse gases are so important, why are they blamed for global warming? Actually, the problem arises when the amount of these gases in

the Earth’s atmosphere exceeds the amount required to maintain temperature balance. This increase in greenhouse gases atmospheric concentration results in trapping of more infrared radiations within the Earth’s atmosphere, and contributes to rise in global average temperature. When it comes to natural causes of global warming that are closely related to greenhouse effect – methane gas release is perhaps the most prominent one. Similarly, anthropogenic causes of global warming which are associated with greenhouse effect include – use of vehicles, stationary sources such as industries, activities such as mining and agricultural, etc.

While naturally occurring greenhouse gases have been playing the important role of regulating the temperature on Earth since several centuries, those gases that are released as a result of human activities have changed the overall picture. These greenhouse gases include carbon dioxide (with a lifetime of 200 years), nitrous oxide (120 years), various CFC’s (with their lifetime ranging between 5 – 1000 years) and gases such as Perfluoropentane and Perfluorohexane (with lifetime exceeding 1000 years).

CONCLUSION & BIBLIOGRAPHY

These impacts of Greenhouse Effect are a dramatically urgent and serious problem. We don’t need to wait for governments to find a solution for this problem: each individual can bring an important help adopting a more responsible lifestyle: starting from little, everyday things. It’s the only reasonable way to save our planet, before it is too late.