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Global Warming and Its Impact on Our Environment, Its Effects and Its Mitigation (An overview)

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Abstract

Global warming and its impact on our environment, our economies and our security, is the defining issue of the era. But every day of inaction makes its consequences more irreversible, so we need to act now. Scientists agree that even a small increase in the global temperature would lead to significant climate and weather changes, affecting cloud cover, precipitation, wind patterns, the frequency and severity of storms, and the duration of seasons.

Rising temperatures would raise sea levels as well, reducing supplies of fresh water as flooding occurs along coastlines worldwide and salt water reaches inland. Many of the world's endangered species would become extinct as rising temperatures will change their habitat. Millions of people would also be affected, especially poor people who live in precarious locations or depend on the land for a subsistence living. Certain vector-borne diseases carried by animals or insects, such as malaria, would become more widespread as warmer conditions expanded their range.

Climate change is a fact of life. We need to act urgently if we are to avoid an irreversible build-up of greenhouse gases (GHGs) and global warming at a potentially huge cost to the economy and society worldwide. OECD analysis suggests that if we act now, we have 10 to 15 years' "breathing space" during which action is possible at a relatively modest cost. But every year of delay reduces this breathing space, while requiring ever more stringent measures to make a difference. Global warming is the increase in the average temperature of Earth's near-surface air and oceans since the mid-20th century and its projected continuation. According to the 2007 Fourth Assessment Report by

the Intergovernmental Panel on Climate Change (IPCC), global surface temperature increased 0.74 ± 0.18 °C during the 20th century.[1] Most of the observed temperature increase since the middle of the 20th century has been caused by increasing concentrations of greenhouse gases.

The greenhouse effect is a process by which radiative energy leaving a planetary surface is absorbed by some atmospheric gases, called greenhouse gases. They transfer this energy to other components of the atmosphere, and it is re-radiated in all directions, including back down towards the earth's surface. This transfers energy to the surface and lower atmosphere, so the temperature there is higher than it would be if direct heating by solar radiation were the only warming mechanism. This is a major cause of Global warming. The greenhouse effect was discovered by Joseph Fourier in 1824, first reliably experimented on by John Tyndall in 1858, and first reported quantitatively by Svante Arrhenius in 1896.[2]

Global warming, a recent warming of the Earth's surface and lower atmosphere,[3] is believed to be the result of a strengthening of the greenhouse effect mostly due to human-produced increases in atmospheric greenhouse gases.[4]Global dimming, a result of increasing concentrations of atmospheric aerosols that block sunlight from reaching the surface, has partially countered the effects of warming induced by greenhouse gases.

Climate model projections summarized in the latest IPCC report indicate that the global surface temperature is likely to rise a further1.1 to 6.4 °C during the 21st century.[1] An increase in global temperature will cause sea levels to rise and will change the amount and pattern of precipitation, probably including expansion of subtropical deserts.[4] Warming is expected to be strongest in the Arctic and would be associated with continuing retreat of glaciers, permafrost and sea ice. Other likely effects include changes in the frequency and intensity of extreme weather events, species extinctions, and changes in agricultural yields. Warming and related changes will vary from region to region around the globe, though the nature of these regional variations is uncertain.[5] Another major[6][7] worldwide concomitant of global warming, and one which is presently happening as well as being predicted to continue, is ocean acidification, which is likewise a result of contemporary increases in atmospheric carbon dioxide.

Keywords: global warming, climate change etc

INTRODUCTION

Global warming is the increase in the average temperature of Earth's near-surface air and oceans since the mid-20th century and its projected continuation. According to the 2007 Fourth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC), global surface temperature increased 0.74 ± 0.18 °C during the 20th century.[1] Most of the observed temperature increase since the middle of the 20th century has been caused by increasing concentrations of greenhouse gases.

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continue, is ocean acidification, which is likewise a result of contemporary increases in atmospheric carbon dioxide.

Basic Mechanism

The Earth receives energy from the Sun in the form of visible light. This light is absorbed at the Earth's surface, and re-radiated as thermal radiation. Some 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. Thus the presence of the atmosphere results in the surface receiving more radiation than it would were the atmosphere absent; and it is thus warmer than it would otherwise be.

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.[9][10]. This is mostly "visible" light; our eyes are adapted to use the most common radiation.
- 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 green house 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 vapor, 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.

- 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.[10] At these wavelengths, greenhouse gases that were largely transparent to incoming solar radiation are more absorbent.[11] Each layer of atmosphere with greenhouses gases absorbs some of the heat being radiated upwards from lower layers. To maintain its own equilibrium, it re-radiates the absorbed heat in all directions, both upwards and downwards. This results in more warmth below, while still radiating enough heat back out into deep space from the upper layers to maintain overall thermal equilibrium. 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.[7]
- The majority of the atmosphere—in particular, O_2 and N_2 which together form more than 99% of the dry atmosphere—is transparent to infrared radiation. Only triatomic (and higher) gases interact with infrared. However, due to intermolecular collisions, the energy absorbed and emitted by the greenhouse gases is effectively shared by the non-radiatively active gases.
- The simple picture assumes equilibrium. 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.

Green House Gases

The major gases which contribute to green house effect are:

water vapor, 36–70%

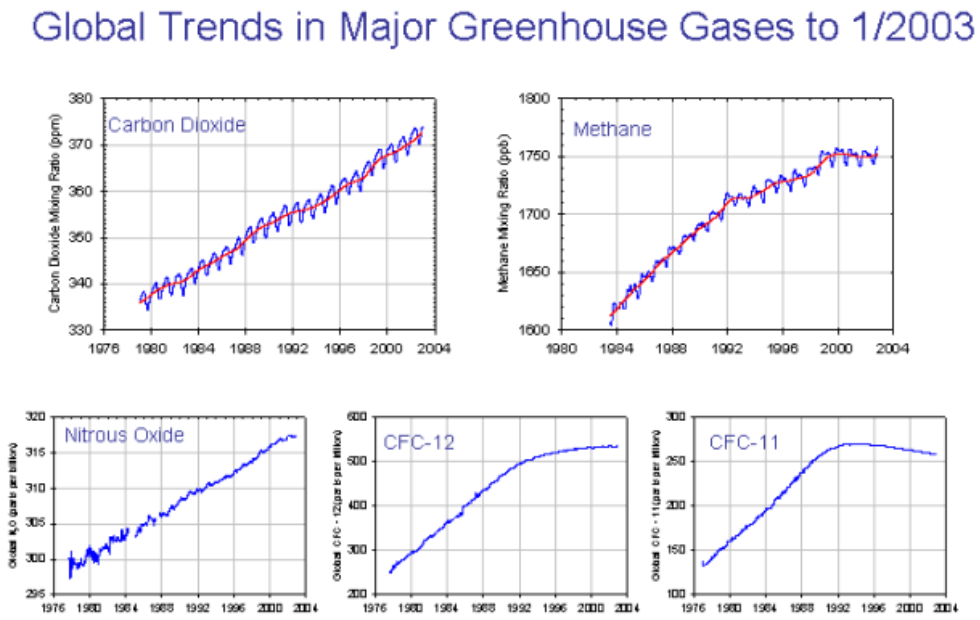
carbon dioxide, 9–26%

methane, 4–9%

nitrous oxide

CFC 11

CFC 12



Global trends in major long-lived greenhouse gases through the year 2002. These five gases account for about 97% of the direct climate forcing by long-lived greenhouse gas increases since 1750. The remaining 3% is contributed by an assortment of 10 minor halogen gases, mainly HCFC-22, CFC-113 and CCl_4.

Carbon Dioxide Emissions are the Biggest Problem, currently carbon dioxide accounts for more than 60 percent of the enhanced greenhouse effect caused by the increase of greenhouse gases, and the level of carbon dioxide in the atmosphere is increasing by more than 10 percent every 20 years. If emissions of carbon dioxide continue to grow at current rates, then the level of the gas in the atmosphere will likely double, or possibly even triple, from pre-industrial levels during the 21st century.

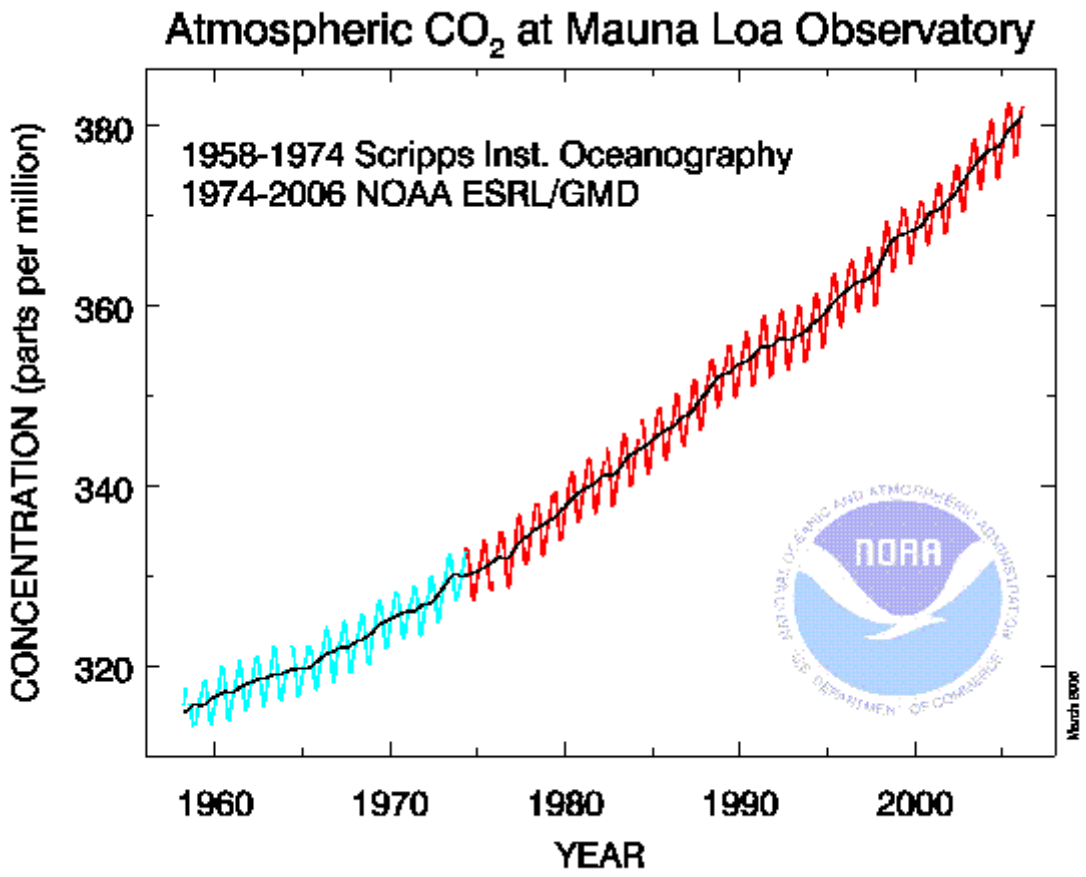


Fig. 2: **Global warming cause: Concentration of carbon dioxide has dramatically increased in the last 50 years** (Source: NOAA)

Effects of Global Warming

The major non-gas contributor to the Earth's greenhouse effect, clouds, also absorb and emit infrared radiation and thus have an effect on radiative properties of the atmosphere.[13] The Scientists agree that even a small increase in the global temperature would lead to significant climate and weather changes, affecting cloud cover, precipitation, wind patterns, the frequency and severity of storms, and the duration of seasons.

- Rising temperatures would raise sea levels as well, reducing supplies of fresh water as flooding occurs along coastlines worldwide and salt water reaches inland.

- Many of the world's endangered species would become extinct as rising temperatures changed their habitat.

- Millions of people also would be affected, especially poor people who live in precarious locations or depend on the land for a subsistence living.

- Certain vector-borne diseases carried by animals or insects, such as malaria, would become more widespread as warmer conditions expanded their range.

How Do Humans Contribute to the Greenhouse Effect?

While the greenhouse effect is an essential environmental prerequisite for life on Earth, there really can be too much of a good thing.The problems begin when human activities distort and accelerate the natural process by creating *more* greenhouse gases in the atmosphere than are necessary to warm the planet to an ideal temperature.

- **Burning natural gas, coal and oil** -including gasoline for automobile engines-raises the level of carbon dioxide in the atmosphere.
- **Some farming practices and land-use changes** increase the levels of methane and nitrous oxide.
- **Many factories produce long-lasting industrial gases** that do not occur naturally, yet contribute significantly to the enhanced greenhouse effect and "global warming" that is currently under way.
- **Deforestation** also contributes to global warming. Trees use carbon dioxide and give off oxygen in its place, which helps to create the optimal balance of gases in the atmosphere. As more forests are logged for timber or cut down to make way for farming, however, there are fewer trees to perform this critical function.
- **Population growth** is another factor in global warming, because as more people use fossil fuels for heat, transportation and manufacturing the level of greenhouse gases continues to increase. As more farming occurs to feed millions of new people, more greenhouse gases enter the atmosphere.

Ultimately, more greenhouse gases means more infrared radiation trapped and held, which gradually increases the temperature of the Earth's surface and the air in the lower atmosphere.

Role in climate change

According to the United Nations, some climate change is already inevitable because of emissions that have occurred since the dawn of the Industrial Age. While the Earth's climate does not respond quickly to external changes, many scientists believe that global warming already has significant momentum due to 150 years of industrialization in many countries around the world. As a result, global warming will continue to affect life on Earth for hundreds of years, even if greenhouse gas emissions are reduced and the increase in atmospheric levels halted.

Strengthening of the greenhouse effect through human activities is known as the enhanced (or anthropogenic) greenhouse effect.[14] This increase in radiative forcing from human activity is attributable mainly to increased atmospheric carbon dioxide levels.[15]

CO_2 is produced by fossil fuel burning and other activities such as cement production and tropical deforestation.[15] Measurements of CO_2 from the Mauna Loa observatory show that concentrations have increased from about 313 ppm [15] in 1960 to about 389 ppm in 2010. The current observed amount of CO_2 exceeds the geological record maxima (~300 ppm) from ice core data. The effect of combustion-produced carbon dioxide on the global climate, a special case of the greenhouse effect first described in 1896 by Svante Arrhenius, has also been called the Callendar effect.

Because it is a greenhouse gas, elevated CO_2 levels contribute to additional absorption and emission of thermal infrared in the atmosphere, which produce net warming. According to the latest Assessment Report from the Intergovernmental Panel on Climate Change, "*most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations*".[15]Over the past 800,000 years, ice core data shows unambiguously that carbon dioxide has varied from values as low as 180 parts per million (ppm) to the pre-

industrial level of 270ppm. Paleoclimatologists consider variations in carbon dioxide to be a fundamental factor in controlling climate variations over this time scale.

Mitigation

To lessen those long-term effects, many nations, communities and individuals are taking action now to reduce greenhouse gas emissions and slow global warming by reducing dependence on fossil fuels, increasing the use of renewable energy, expanding forests, and making lifestyle choices that help to sustain the environment.

Reducing the amount of future climate change is called mitigation of climate change. The IPCC defines mitigation as activities that reduce greenhouse gas (GHG) emissions, or enhance the capacity of carbon sinks to absorb GHGs from the atmosphere. Many countries, both developing and developed, are aiming to use cleaner, less polluting, technologies. Use of these technologies aids mitigation and could result in substantial reductions in CO_2 emissions. Policies include targets for emissions reductions, increased use of renewable energy, and increased energy efficiency. Studies indicate substantial potential for future reductions in emissions. Since even in the most optimistic scenario, fossil fuels are going to be used for years to come, mitigation may also involve carbon capture and storage, a process that traps CO_2produced by factories and gas or coal power stations and then stores it, usually underground.

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