DEEPEN YOUR UNDERSTANDING ABOUT GREEN HOUSE GASES

Greenhouse gases keep our planet warm
Greenhouse gases (GHG) are gases like naturally occurring water vapour, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O) and man-made halocarbons like chlorofluorocarbons. These gases are needed to keep our planet warm. They act for the earth like a greenhouse for plants: letting solar energy in but preventing heat from getting out. This is called the greenhouse effect. GHGs absorb 90 % of the heat radiated from the earth's surface (soil and seas).

Excess of greenhouse gases reason for current climate change
GHGs in excess cause an accelerated warming of the climate. The higher concentration of GHGs in the atmosphere, the stronger the heating effect and the bigger the temperature increase. The accumulated GHGs in the atmosphere seems to be the main reason for the climate change (global warming) we are experiencing today.

CO_2 emissions main contributor to global warming
Plants, animals and humans respire (breath), biomass decays, some forests burn naturally and oceans release CO_2. These natural CO_2 emissions do not accumulate in the atmosphere. CO_2 that is accumulated in the atmosphere and contributes to the greenhouse effect originates mainly from the burning of fossil fuels (coal, oil, natural gas), deforestation in the tropics and industrial processes. Carbon dioxide, CO_2, accounts for ca. 74% of the anthropologic (human induced) GHG emissions and generates ca.55 % of the human induced greenhouse effect.

CO_2 stays for long in the atmosphere and concentrations are increasing
For 400000 years the concentration of CO_2 in the atmosphere was stable between 200 (ice age and ice at it's thickest) and 280 ppm (normal climate). Since 1750 the concentration has increased to almost 390 ppm and is increasing with about 2 ppm/a. This does not sound much to worry about, but it is a problem because, CO_2 is chemically stable in the atmosphere. It stays there approximately 100 years until it is either used up by the plants in photosynthesis or dissolved in the ocean and converted to bicarbonate and carbonate ions.

Nature can reduce only 1/3 of our CO_2 emissions
It's our luck that earth's carbon sinks, the oceans and the vegetation including forests, swamps and marshes, for the time being still are able to deal with more CO_2 than those originating from the naturally occurring emissions. Nature's yearly capacity to reduce anthropogenic CO_2 is currently ca.3 Gt of Carbon equivalents or 11,7 Gt of CO_2. Note that this is only 1/3 of the total anthropogenic CO_2 emissions of today. The rest is to be added to the CO_2 that is already accumulated in the atmosphere. There it will warm the climate while waiting to be processed.

Carbon sinks may turn into carbon sources
A problem with a warming climate is the weakening of the carbon sinks. Their capacity to process CO_2 decrease with increasing temperatures. At some stage these sinks may turn into CO_2 sources. For example marshes and swamps around the world store ca.450 Gt carbon (≈1650 Gt CO_2). A couple of degrees increase in earth's temperature could release 25 % of the carbon and turn these sinks to CO_2 sources.

Awecore Oy / Koivurinteentie 115 / FIN-03300 Otalampi / tel +358 9 222 4466 / +358 400 700 142 / fax +358-9-222 4442
e-mail: info@awecore.com / www.awecore.com

Methane is also a significant contributor to global warming
Methane, CH_4, is formed when an organic compound decays in the absence of oxygen. It can be found in seabed and in swamps. Termites emit CH_4. The food that ruminants ingest, ferment in the stomach and cause emissions of CH_4. Human induced CH_4 emissions originate from biomass combustion (wood burning, especially burning forests in the tropical zone to release space for agricultural activities.), increased cattle breeding, rice cultivation and dumps. Furthermore CH_4 is released through leaks linked to drilling and transportation of natural gas. Methane accounts for 17 % of the anthropogenic GHG emissions and generates ca.15 % of the human induced greenhouse effect.

Methane is more potent than CO_2
Like CO_2 also CH_4 has increasingly accumulated into the atmosphere. The concentration of CH_4 in the atmosphere was ca. 0,72 ppm in 1750, today ca. 1,8 ppm. This is alarming because, CH_4 is at least 25 times as strong a greenhouse gas as CO_2 and, the average residence time for CH_4 in the atmosphere is 12 years. This is not a long time. But, after this period the CH_4 is converted into CO_2, which will stay another 100 years in the atmosphere. This happens because CH_4 will react with hydroxyl radicals, OH^- to form water and CO_2.

Hydroxyl radicals OH^- act as atmospheric cleaners reacting with impurities like carbon monoxide and hydro-fluorocarbons. Unfortunately amount of $^{OH-}$ is decreasing because of increasing amounts of impurities in the air. This shortage will lead to further accumulation of CH_4.

Methane - a ticking bomb?
Deep down in the seas in cold temperatures and high pressure ca. 10000 Gt of carbon is stored in the form of methane hydrates. Increasing temperatures may start eruption of this compound. This happened 55 million years ago under a period of ca. 10000 years. As a result the CO_2 concentration in the atmosphere increased from 500 ppm to 2000 ppm and the average temperatures increased 5°C - 8°C. It took more than 100000 years for the earth to recover from that.

There is also a lot of carbon stored under the ground in the frozen soil in the arctic peat swamps in Siberia and Alaska. The amount of stored carbon only in north Siberia is ca. 500 Gt (≈1830 Gt CO_2 ≈73 Gt Methane), half of which are stored less than 1 m below the surface. A temperature increase of the earth of 2°C may release 25 % (125 Gt C) of the carbon when the frozen soil in these swamps thaws. Depending on humidity, the carbon is released to the atmosphere either as methane or CO_2. In any case, it is a considerable amount remembering that the nature currently only can process extra carbon at a maximum of 3 Gt/a.

Fertilizers and nitric acid production reason for nitrous oxide emissions
Nitrous oxide, N_2O is a by-product of microbial activity in the soil. Two thirds of the N_2O in the atmosphere is naturally formed, mainly in the humid zones. The rest is a result of human activities. We talk mainly about the use of fertilizers and the production of nitric acid. N_2O, accounts for 8 % of the GHG emissions and generates ca.5 % of the human induced greenhouse effect.

Nitrous Oxide is a strong GHG but not regarded a big problem (yet)
N_2O is almost 300 times stronger a greenhouse gas than CO_2. Its residence time in the atmosphere is 120 years. The concentration of N_2O in the atmosphere was 0,29 ppm in 1750 and is today appr. 0,32 ppm. It is continuously increasing, but is fortunately still relatively small. N_2O is decomposed in the atmosphere through high energy UV radiation. This reaction is possible only in the upper layers of the atmosphere.

Halocarbons are extremely powerful greenhouse gases

Halocarbons are man-made GHGs obtained by substituting all or part of the hydrogen in a hydrocarbon (propane, butane, etc.) with a halogen gas (chlorine, iodine, fluorine, etc.). These compounds are used in devices that generate cold and in a number of industrial processes.
Ca. 1 % of the GHG emissions are halocarbons and they generate ca.10% of the human induced greenhouse effect.

Halocarbons deserve to be treated with greatest respect. Some can be a thousand-fold more efficient as a greenhouse gas than CO_2. Some of them are very stable and can stay thousands of years in the atmosphere before broken down by very strong UV radiation.

Water vapour, efficient, but, not considered significant for the climate change
Despite water vapour being the most efficient of the greenhouse gases, man made water vapour emissions do not have an effect on climate change. The life cycle of water is so short that water molecules will return to earth as rain after less than two weeks in the atmosphere.

SOURCES – GREENHOUSE GAS INFORMATION

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