

# **Green House Effect**

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# **GREEN HOUSE EFFECT (GHE)**

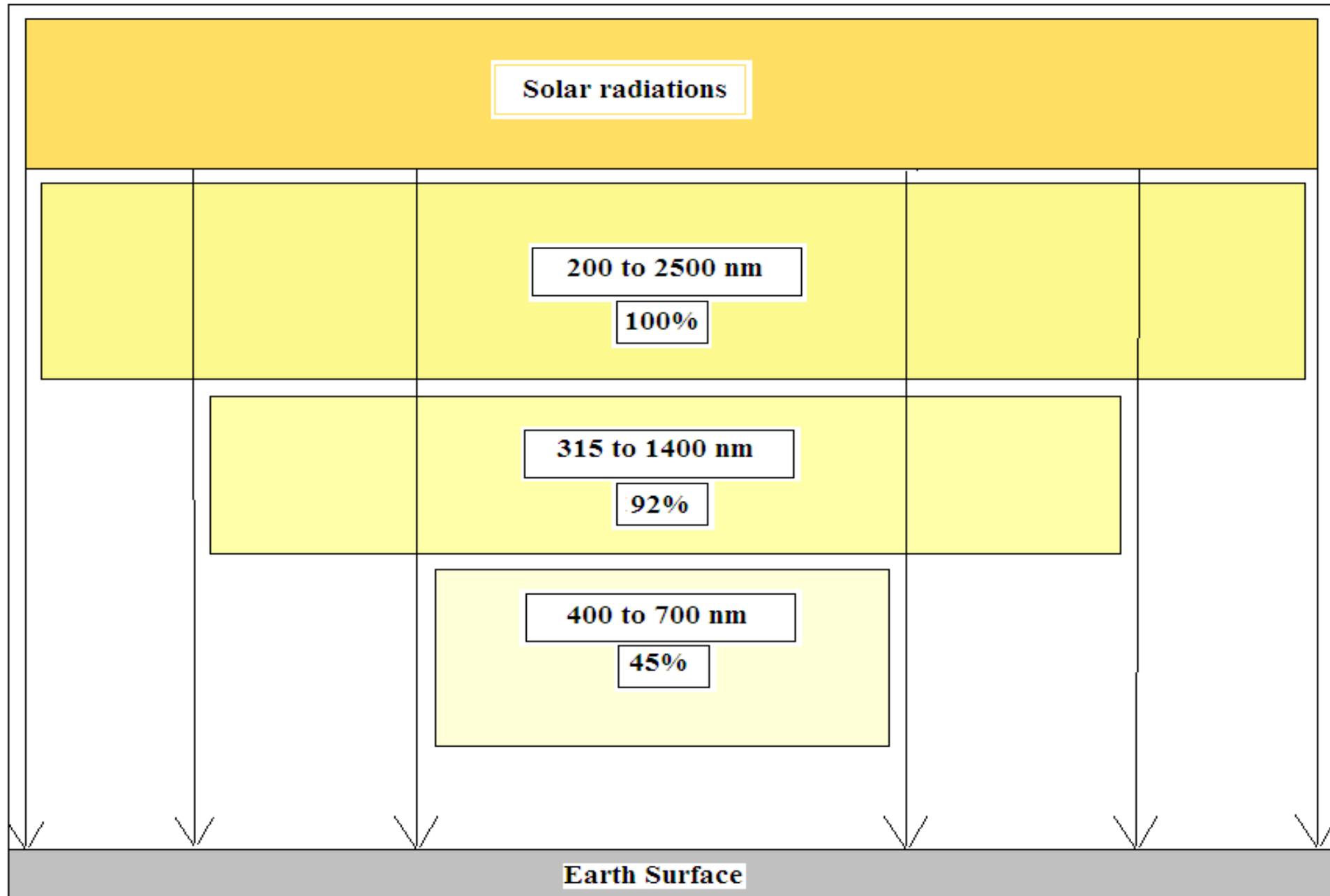
Earth is heated by sunlight and some of the heat absorbed by the Earth is re-radiated back in to space. However some of the gases in lower atmosphere like  $\text{CO}_2$ ,  $\text{H}_2\text{O}$  vapour,  $\text{CH}_4$  and CFCs do not allow to re-radiate this heat into space. They absorb some heat and send back a part of it to the Earth again. Therefore the Earths surface gets heated and temperature above  $0^\circ\text{C}$  is maintained. This Phenomenon is commonly known as Green House Effect.

# Solar Radiations Absorption

The solar radiations falling on the Earth are in the range of 300 to 2500 nm, i.e. near U.V., Visible and near I.R.

The gases present in lower atmosphere allow these radiations to fall on the Earth like glass in green house.

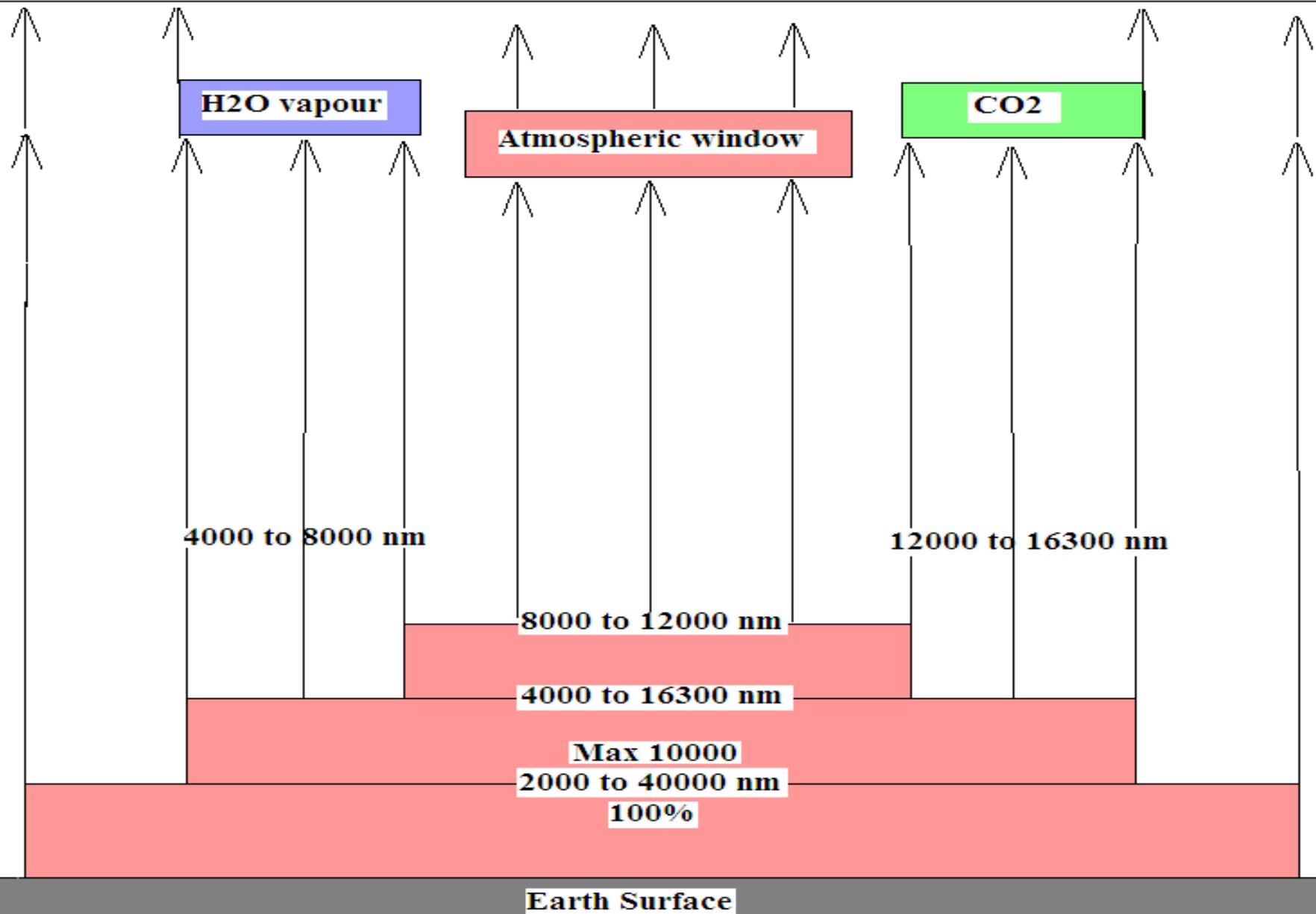
# Solar Radiations : Absorption



# Radiations Emission by Earth

The Earth emits the heat thus absorbed from sun in the form of I. R. radiations in the range of 2000 to 40,000 nm with the majority radiations of 4000 to 16,300 nm and with a maximum of about 10,000 nm.

# I.R. Radiations: Emission by Earth

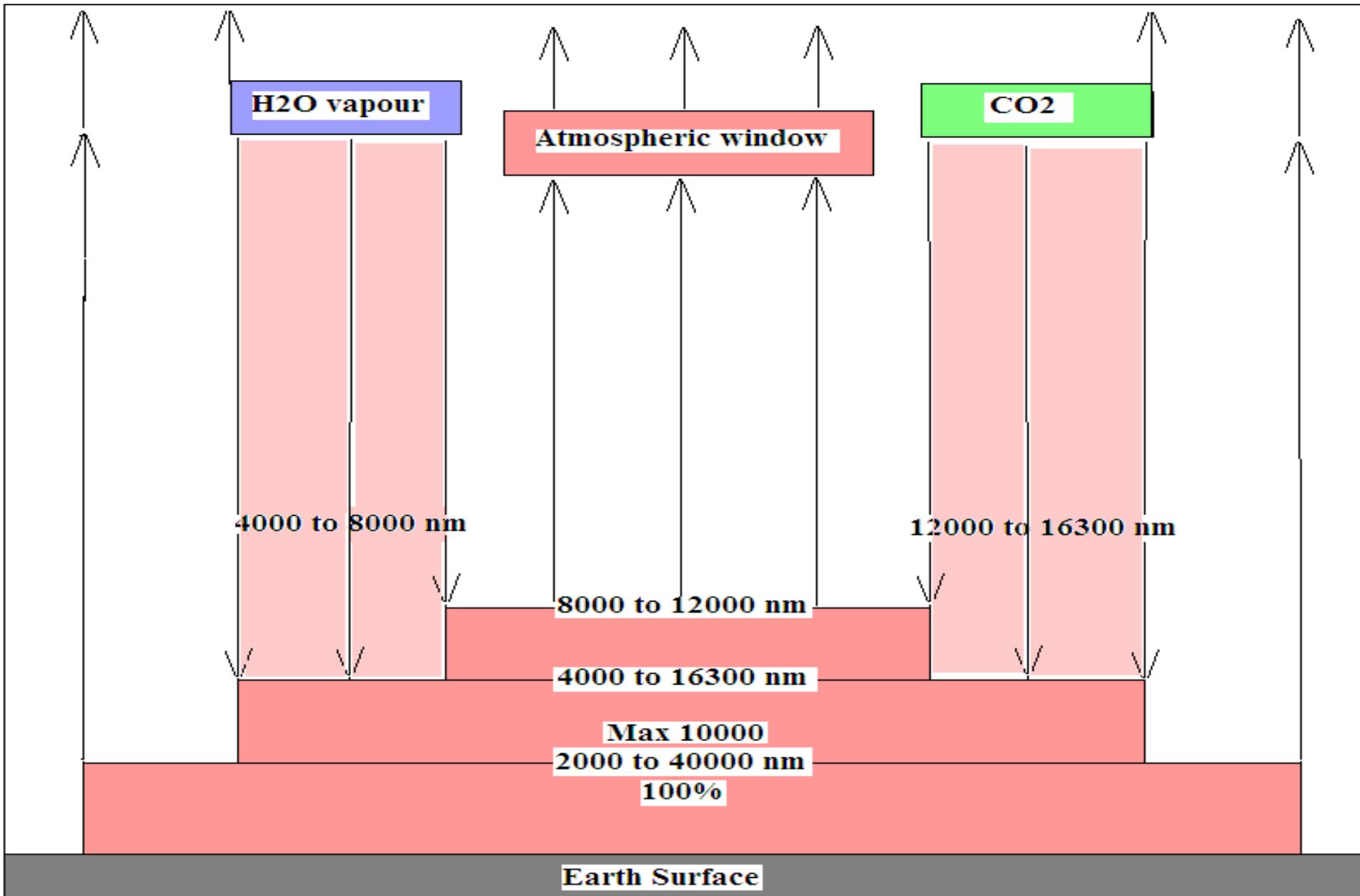


## **I.R. Energy absorption & re-emission by GHGs**

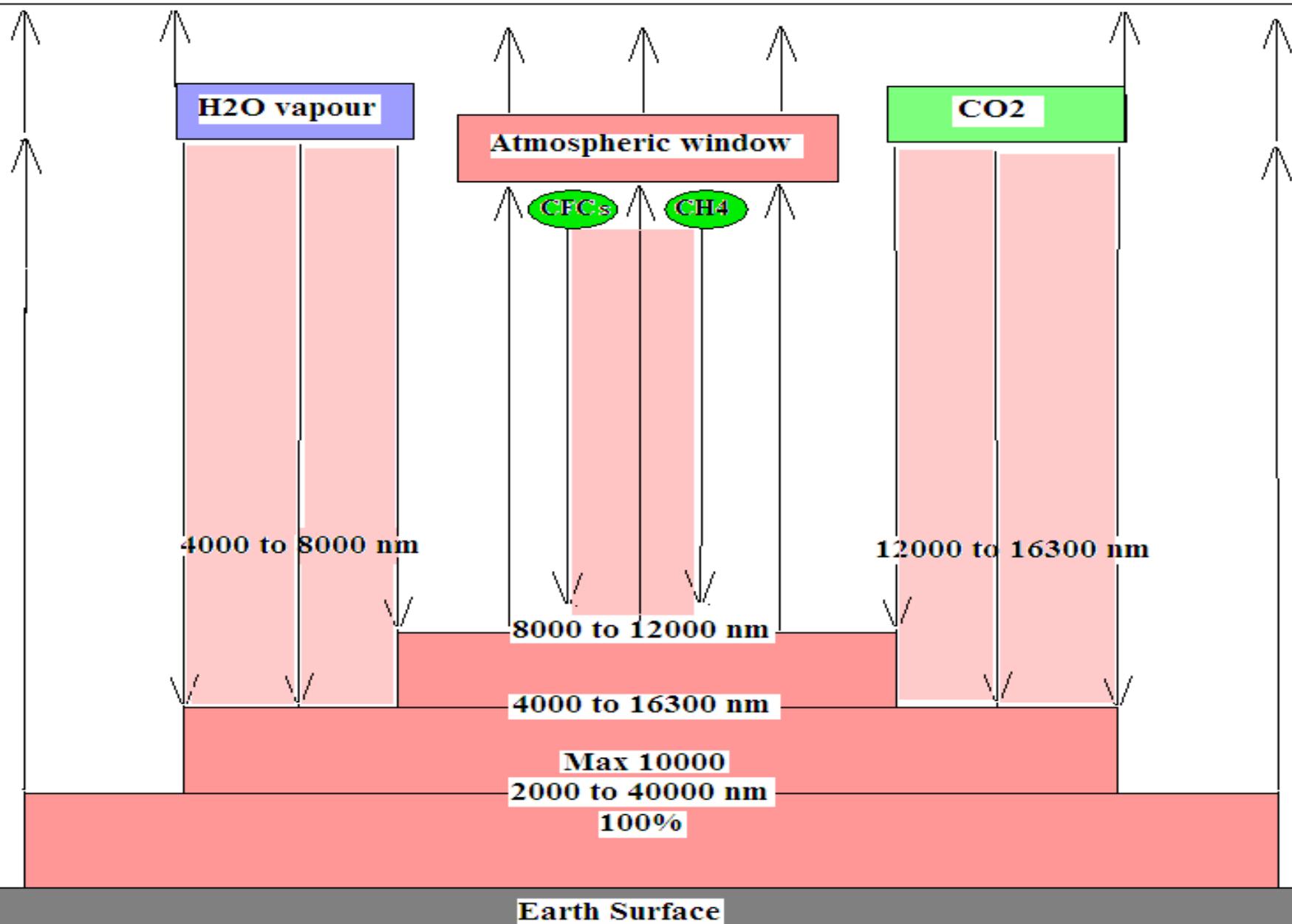
Water vapour absorb the I.R. radiations of 4000 to 8000 nm while CO<sub>2</sub> absorb that of 12,000 to 16,300 nm and re-radiate them back to the earth. Due to this the earths average temperature is maintained at about 15<sup>0</sup>C otherwise it would have been -18<sup>0</sup>C.

The I.R. radiations in the region of 8000 to 12000 nm are escaping unabsorbed. This has avoided over heating of the earth. This region is commonly referred as the region of atmospheric window or optical window.

# I.R. Energy absorption & re-emission by GHGs



# Enhanced GHE



# **GREEN HOUSE GASES (GHG)**

- 1. Carbon dioxide (CO<sub>2</sub>)**
- 2. Chlorofluorocarbons (CFCs)**
- 3. Methane (CH<sub>4</sub>)**
- 4. Nitrous Oxide (N<sub>2</sub>O)**

# 1. Carbon dioxide (CO<sub>2</sub>)

Carbon dioxide contributes about 55% to global warming from green house gases produced by human activity.

Industrial countries account for about 76% of annual emissions.

Main sources are fossil fuel burning(67%), deforestation, other forms of land clearing & burning (33%).

**CO<sub>2</sub>** stays in the atmosphere for about 500 yrs

**CO<sub>2</sub>** concentration in the atmosphere was 355 ppm in 1990 that is increasing at a rate of 1.5 ppm every year. (Source: IPCC)

# 1. Carbon dioxide (CO<sub>2</sub>)

Table: Increase in concentration of atmospheric CO<sub>2</sub> since 1800

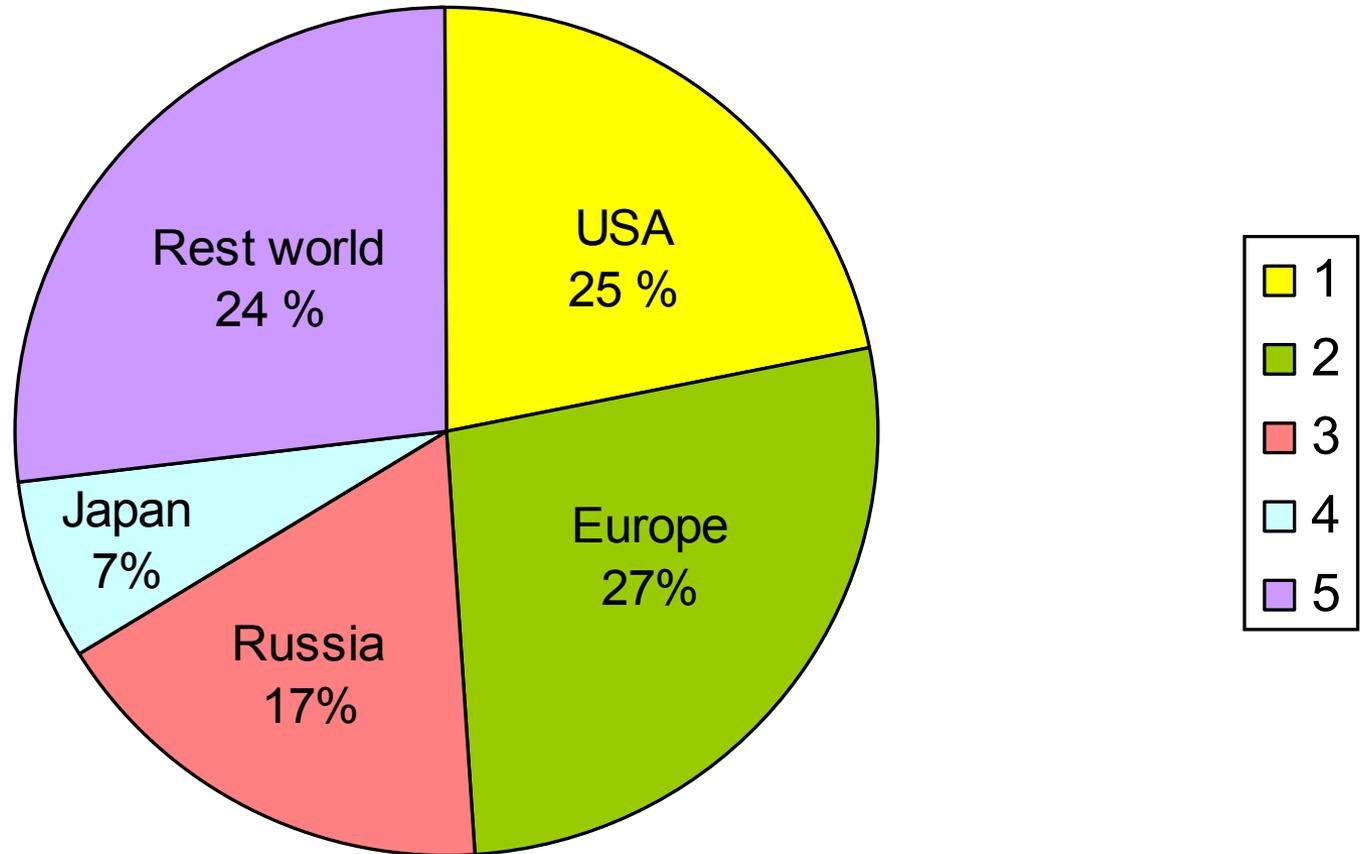
Year	1750	1800	1850	1900	1960	1990	2005
CO <sub>2</sub> concn (ppm)	280	280	285	295	315	355	375

Table: Contribution of developed nations in annual CO<sub>2</sub> Emission

Globe	America	Europe	Russia	Japan	Total
CO <sub>2</sub> emission	25 %	27 %	17 %	07 %	76 %

# Annual Carbon dioxide Emissions

## CO2 Emission 2000



Annual CO<sub>2</sub> Emissions by Industrial countries(source:IPCC)

## 2. Chlorofluorocarbons (CFCs)

These are believed to be responsible for 25 % of the human contribution to global warming.

The main sources of CFCs include leaking air conditioners & refrigerators, evaporation of industrial solvents, production of plastic foams, aerosols, propellants etc.

CFCs stay in the atmosphere for about 65-100 yrs

CFCs generally trap 1500 to 7000 times more heat per molecule than CO<sub>2</sub>.

Atmospheric concentration of CFC is 0.00225 ppm that is increasing at a rate of 0.5% annually.

### **3. Methane (CH<sub>4</sub>)**

It accounts for 15% of increased GHGs.

Methane is produced when bacteria break down dead organic matter in moist places that lack oxygen such as swamps, natural wetlands, paddy fields, landfills and digestive tracts of cattle, sheep and termites. Production and use of oil and natural gas and incomplete burning of organic material are also significant sources of methane.

Methane stays in the atmosphere for 7-10 years.

Each methane molecule traps about 25 times as much heat as a CO<sub>2</sub> molecule.

Atmospheric concentration of methane is 1.675 ppm and it is increasing at a rate of 1 % annually.

## 4. Nitrous Oxide (N<sub>2</sub>O)

It is responsible for 5 % of the human input of green house gases (GHGs).

It is released from nylon products, from burning of biomass and nitrogen rich fuels (especially coal) and from the break down of nitrogen fertilizers in soil, livestock wastes and nitrate-contaminated ground water.

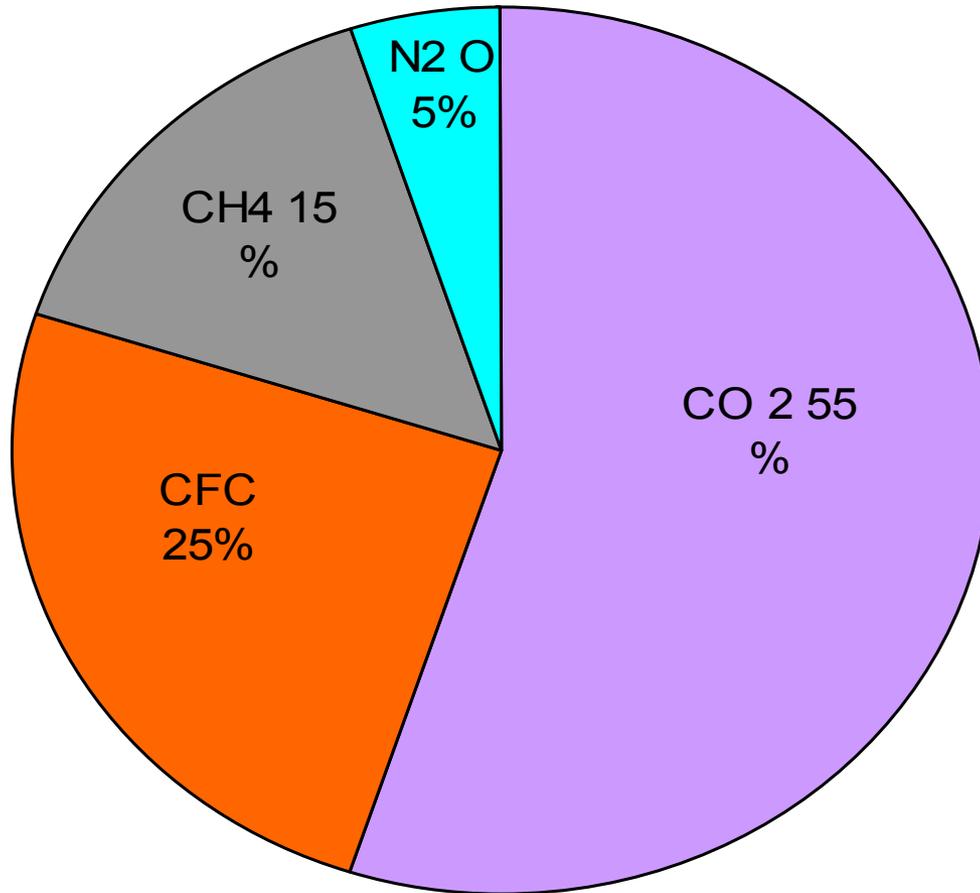
Its life span in the troposphere is 140-190 years.

It traps about 230 times as much heat per molecule as CO<sub>2</sub>.

The atmospheric concentration of N<sub>2</sub>O is 0.3 ppm and is increasing at a rate of 0.2% annually.

# Enhanced Green House Effect

## Green House Effect



Individual contribution of Green House Gases to warming in 2000

# Enhanced Green House Effect

<b>GHG</b>	<b>Warming (%)</b>	<b>Concn (ppm)</b>	<b>Increase per yr</b>	<b>Heat trapping</b>	<b>Retention time</b>
<b>CO<sub>2</sub></b>	55	360	1.5 ppm	1 time	500 yrs
<b>CFCs</b>	25	0.0025	0.5 %	1500-7000 time	65-110 yrs
<b>CH<sub>4</sub></b>	15	1.675	1.0 %	25 time	7-10 yrs
<b>N<sub>2</sub>O</b>	05	0.31	0.2 %	230 time	140-190 yrs
<b>O<sub>3</sub></b>	Unknown	0.02	--	--	--

Green House Effect in 2000 (source: IPCC)

# Enhanced Green House Effect

SN	GHG	Concentration in ppm		Percent Change
		1750	2000	
1	CO <sub>2</sub>	280	370	30
2	CFCs	00	0.0023	--
3	CH <sub>4</sub>	0.7	1.7	145
4	N <sub>2</sub> O	0.028	0.031	11

Enhanced concentration of green house gases (source: IPCC)

# Significance of Green House Effect

Since last 10,000 years the average global temperature is stabilized at  $15^{\circ}\text{C}$ .

In the absence of green house effect this would have been  $-18^{\circ}\text{C}$ .

Therefore, Green House Effect contributes a net temperature rise to the tune of  $33^{\circ}\text{C}$  [i.e. from  $-18^{\circ}\text{C}$  to  $+15^{\circ}\text{C}$ ].

If concentration of green house gases is larger, planets temperature would have been quite high. [Venus temperature is  $425^{\circ}\text{C}$  as its  $\text{CO}_2$  concentration is 60,000 times to that of earth]

# **Role of Green House Gases**

Heat trapped by green house gases in the atmosphere keeps the planet warm enough to allow us and other species to exist.

The two predominant green house gases are water vapours, which are controlled by hydrological cycle, and carbon dioxide, which is controlled mostly by the global carbon cycle.

While the levels of water vapour in the troposphere have relatively remained constant, the levels of carbon dioxide have increased considerably in last two centuries.

# Enhanced Green House Effect

Oceans and Biomass are the major sinks for atmospheric  $\text{CO}_2$ . Oceans convert  $\text{CO}_2$  into soluble bicarbonates while green plants consume  $\text{CO}_2$  in photosynthetic activity. As such the Forests maintain a balance in atmospheric  $\text{CO}_2$  level.

However in last century about 67% forest cover is lost. The deforestation has upset the balance and atmospheric  $\text{CO}_2$  level has increased considerably.

# Enhanced Green House Effect

It is estimated that the atmospheric CO<sub>2</sub> content has increased by 35% during last two centuries, which caused an increase of 0.7° C in average global temperature.

Other gases whose levels have increased due to human activities are Methane, Nitrous oxide & Chlorofluorocarbons.

The heat trapping capacity of these gases is quite high as they capture and send back the I.R. radiations of the region of atmospheric window i.e. of 8000 to 12000 nm with the maximum of 10,000 nm.

# Global Warming

On account of anthropogenic activities there is an increase in the concentration of the greenhouse gases in the air that absorb heat contained in IR light and re-radiate even more of the out going thermal infra-red energy, thereby increasing the average temperature beyond 15°C.

The phenomenon is referred to as the enhanced green house effect to distinguish its effect from the one that has been operating naturally for millennia.

The net consequence of the phenomenon of enhanced green house effect is commonly referred as global warming.

# **Basic causes of Global Warming**

Rapid increase in the concentration of green house gases due to anthropogenic activities is the main cause of the global warming.

The anthropogenic activities are as under:

- Deforestation
- Vast Industrialization
- Population explosion
- Increased burning of fossil fuels.
- Increase in number of Automobiles
- Increase in mining activities.

# **Global Warning**

If proper precautions are not taken, the concentration of green house gases may double within the next 50-100 years and the global temperature may increase by 4 - 5°C. This may destroy the delicate balance that existed in last 10,000 years amongst the various biotic and abiotic components of the nature, may adversely affect the functioning of various ecosystems, hydrological cycle and biogeochemical cycles. Very survival of life will be threaten under these conditions.

# **Global Warming: Consequences**

- Uncontrollable impact on climate
- Increase in planet temperature
- More evaporation of surface water
- Change in pattern of cloud formation
- Adverse effect on food production
- Melting of polar ice caps and glaciers
- Lifting of sea levels
- Tropical storms
- Adverse effect on animal breeding
- Increase in number of diseases.

# Control measures

Global warming could be minimized by practicing:

1. Reduction in use of fossil fuels and encouraging use of alternative sources of energy such as solar geothermal, wind, biogas, etc.
2. Conservation of Forests, extensive a forestation, encouraging community forestry, etc
3. Development of more efficient automobile technology, reduction in the use of automobiles, etc.
4. Ban on CFCs and Nuclear explosions.
5. Effective check on population growth
6. Development of compatible Environmental technology with the help of intensive interdisciplinary research.
7. Imparting informal and formal Environmental Education.

# Global Dimming

As per a Report-2003 on Environment, since 1960 the amount of direct solar radiations reaching the earth surface has decreased by 2 to 4%. The phenomenon is commonly referred as Global Dimming.

The decrease is due to increase in cloud cover & the particulate matter in the atmosphere.

Burning of fossil fuels pumps tiny particles in the atmospheric air. This leads to an increase in cloud cover at high temperature. The tiny particles block & scatter the sun radiations and thus lower the overall light reaching the earth.

# Global Dimming

Scattered light takes a zigzag path, bathing every part of the plant leaves instead of focusing just one surface. This increases the rate of photosynthesis even though the amount of overall light is reduced. As such it enhances the rate of removal of atmospheric CO<sub>2</sub> thereby exerting an effective check on global warming.

As such in the form of global dimming nature has initiated a phenomenon opposite to global warming.

(Source: A presentation by an Australian scientist at a joint assembly of American & Canadian Geophysical Union at Montreal on 15<sup>th</sup> May 2004).