ENVIS- IITM NEWSLETTER

The Air Quality: A Global Challenge

Editorial
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EDITORIAL

ENVIS-IITM centre deals with the very important and sensitive component of the environment "The Air we breathe" and related challenges. In our last series of newsletters under the heading "Air Pollution Chemistry" we have taken a brief knowledge of Earth system, interdependence of different components of environment, the atmosphere, air pollution, criteria air pollutants etc. Alteration in the natural composition of the air can harm not only the health of human being but also it affects the health of environment which will eventually end up with the imbalance in the functioning of Earth System resulting in to the local, regional and global challenges. ENVIS-IITM is introducing a new series "The Air Quality: A Global Challenge", where we will discuss about various local, regional and global impacts resulted due to the atmospheric pollution along with their causes and effects. In the first two parts of the series we have covered the regional problem "Acid rain and its effects".

Present issue will deal with the causes for most striking problem of recent period "Climate Change". We hope our attempt to convey complicated scientific information in simple language will help to create awareness amongst the common public which is the first step towards safeguarding our environment.

Inside the Issue

What is Climate?

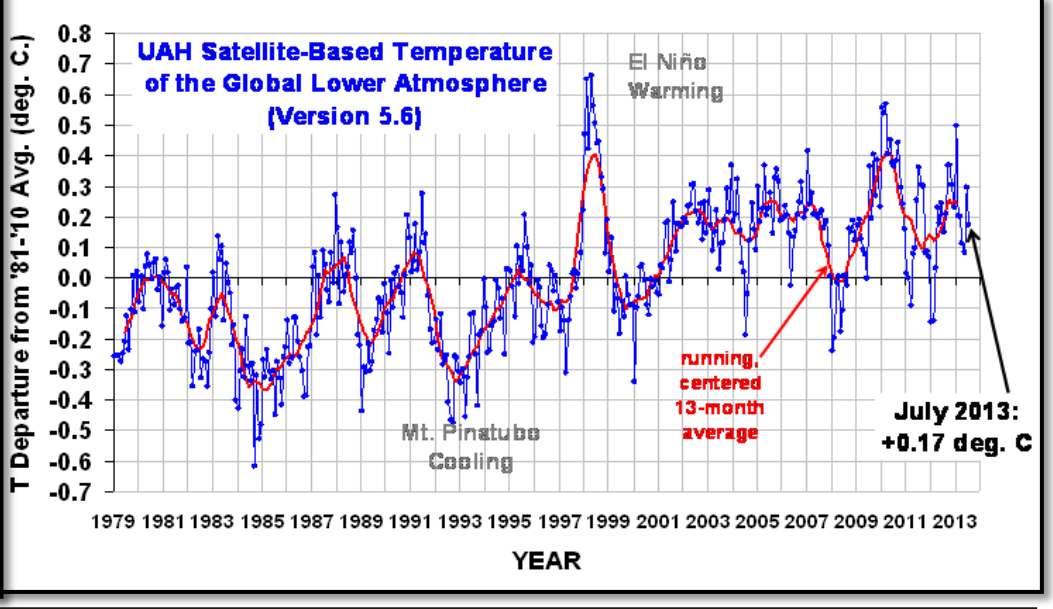
To understand the climate change firth we need to know the difference between weather and climate.

Weather: **Weather refers to the condition of atmosphere over a short period of time, such as hours or days, and typically for a local area. It includes the daily temperature, humidity, amount of precipitation etc. it also includes severe weather conditions such as hurricanes, tornadoes and blizzards.**

Climate: **Climate refers to the behavior of atmosphere over a longer period of time and usually for a larger area. Climate is typically defined based on 30 years average weather. Hence we can say climate represents our expectations for weather.**
Eg. Climate tell us how warm will be a typical summer, how cold will be a typical winter, how frequently we expect the precipitation in the year etc.

Climate Change:

Increase in Global Average Temperature



The Global Average Temperature has increased about 0.8 °C (1.4°F) since the early 20th century.

Why we are concern about changes in temperature?

The impact of climate change varies from region to region around the globe. The effects of an increase in global temperature includes

- **Rise in sea level**
- **Changes in the amount and pattern of precipitation**
- **Probable expansion of subtropical deserts**
- **Retreat of glaciers, permafrost and sea ice**
- **Increase in the frequency of extreme weather events including heat waves, droughts and heavy rainfall**
- **Ocean acidification**
- **Species extinctions due to shifting temperature regimes**

Threat to FOOD SECURITY, WATER SECURITY, ENERGY SECURITY,

LOSS OF HABITAT

Do You Know

- **262 million people were affected by climate change in 20014, more than 98% of them in developing counties**
- **30 million people are likely to go hungry as agricultural yield decline across the globe**
- **WHO estimates that 150,000 lives being already lost each year**

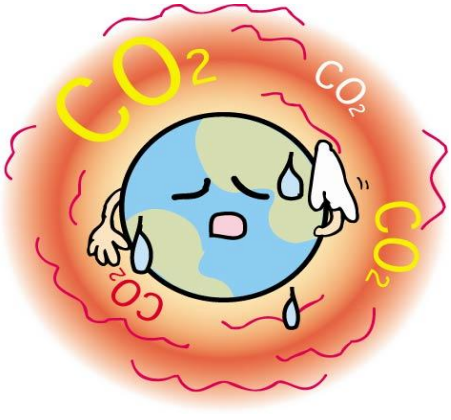
What is responsible for climate change?

Natural Processes: Changes in the sun's energy, shifts in the ocean currents volcanic eruptions can affect Earth's climate. However, research shows that they do not explain the warming that we have observed since mid of 20th century.

Human causes: Most of the observed increase in the temperature since the mid 20th century is a result of various anthropogenic activities.
This includes;

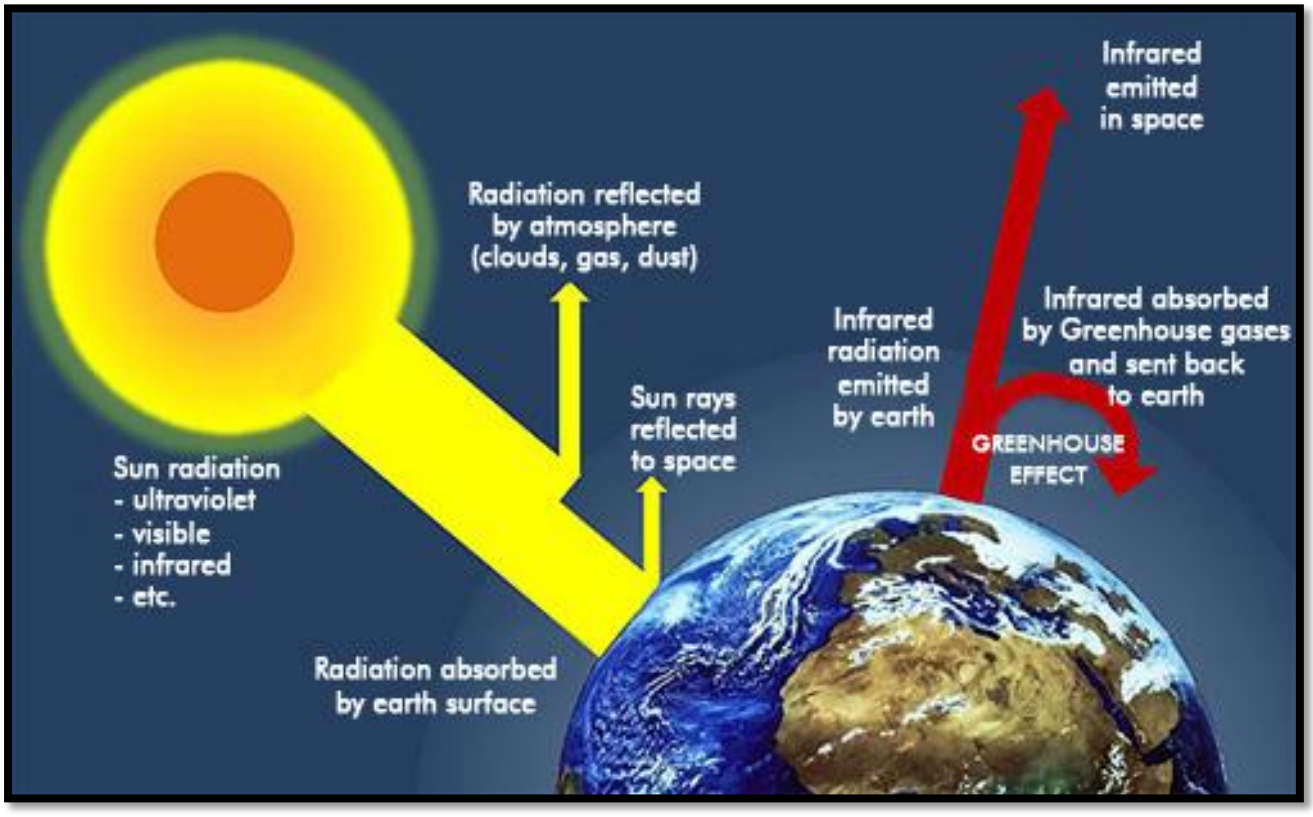
Emission of Greenhouse Gases (GHG)
Emission of Particles and soot

Greenhouse Gases (GHG)



A number of trace gases present in the atmosphere allows short-wave solar radiation to pass through it and at the same time they partially absorb long-wave radiations emitted by the warm surface of the earth and reradiated in all directions, downwards as well as upwards. This effect is known as Green House Effect and these trace gases are known as Green House Gases (GHG). Many gases exhibit these "greenhouse" properties. Thus temperature of the earth surface is mainly controlled by the concentration of GHGs in the atmosphere. At their normal concentrations they have a mean warming effect of about 33°C. It means GHG's greatly affects the temperature of the Earth and help to keep Earth warmer, without them, Earth's surface would become 33°C colder than what it is at present.

Greenhouse Effect



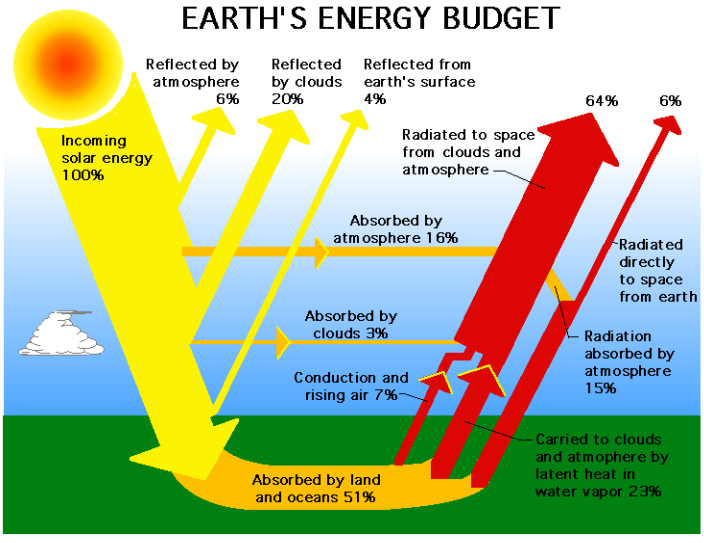
The Greenhouse effect is the process by which absorption and emission of infrared radiation by gases in planet's atmosphere warm its lower atmosphere and surface. When concentration of GHGs altered, their contribution to the greenhouse effect also shifts. It may results in the increase or decrease in the temperature of the earth's surface. Climate change caused by an increased concentration of these greenhouse gases has an alarming impact on our environment. The Intergovernmental Panel on Climate Change (IPCC) concludes that "increasing greenhouse gas concentrations resulting from different human activity are responsible for most of the observed temperature increase since the middle of the 20th century".

GHG's presents in Earth's atmosphere

Some of them occur in nature (**water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (NO_2), ozone (O_3), aerosols**), while others are exclusively human made (**e.g. chlorofluorocarbon**).

Concept of Radiative Forcing

The Earth absorbs some of the radiant energy received from the sun, reflects some of it as light and reflects or re-radiates the rest back to the space as heat. The Earth's surface temperature depends on this balance between incoming and outgoing energy. If this energy balance is shifted, the Earth's surface could become warmer or cooler, leading to a variety of changes in global climate.



A number of natural and man-made mechanisms can affect the global energy balance and force changes in the Earth's climate. **Greenhouse gases are one such mechanism.** Factors that influence Earth's energy balance can be quantified in terms of "**radiative climate forcing.**" Positive radiative forcing indicates warming (for example, by increasing incoming energy or decreasing the amount of energy that escapes to space), while negative forcing is associated with cooling.

How strong they are? Global Warming Potential (GWP)

The contribution of each gas to the greenhouse effect is different. It is affected by the factors like abundance, atmospheric life time etc. For example, the direct radiative effect of a mass of methane is about 72 times stronger than the same mass of carbon dioxide over a 20-year time frame but it is present in much smaller concentrations so that its total direct radiative effect is smaller, in part due to its shorter atmospheric lifetime. The global warming potential (GWP) depends on both the efficiency of the molecule as a greenhouse gas and its atmospheric lifetime. GWP is measured relative to the same mass of CO_2 and evaluated for a specific timescale. Carbon dioxide is defined to have a GWP of 1 over all time periods

Atmospheric life time & GWP relative to CO_2

Gas name	Chemical formula	Lifetime (years)	Global warming potential (GWP) for given time horizon		
			20-yr	100-yr	500-yr
Carbon dioxide	CO_2	100	1	1	1
Methane	CH4	12	72	25	7.6
Nitrous oxide	NO2	114	289	298	153
CFC-12	CCl2F2	100	11 000	10 900	5 200
HCFC-22	CHClF2	12	5 160	1 810	549
Tetrafluoromethane	CF4	50 000	5 210	7 390	11 200
Hexafluoroethane	C2F6	10 000	8 630	12 200	18 200
Sulfur hexafluoride	SF6	3 200	16 300	22 800	32 600
Nitrogen trifluoride	NF3	740	12 300	17 200	20 700

Biomass, Biofuel, Fossil fuel burning, agricultural activities including fertilizers, livestock enteric fermentation and manure management, paddy rice farming, land use etc. are some of the major sources of GHG's.

Carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, hydroflurocarbons and perflurocarbons are major anthropogenic greenhouse gases and are regulated under the Kyoto Protocol international treaty, which case in force in 2005.

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