

Lecture - 4 SC209Atmospheric molecular interaction

→ Molecular bonds stretch & bend after absorbing IR electro. rad.  
Why?

~~Atmosphere~~

Greenhouse gases concentration → highest in Troposphere.  
→ IR from earth & Sun absorbed by GHGs in Tropos.

On hot day → it feels so because  $N_2$  &  $O_2$  → High K.E.  
But  $N_2$  &  $O_2$  → X absorb IR because charges are evenly distributed. → How do they gain energy?

∴ they gain energy by collisional excitation.

Wave no.  $\propto \frac{1}{\text{wavelength}}$

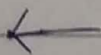
→ At a particular wavelength, unique for different gases absorb energy at that particular  $\lambda$  because of the vibr<sup>n</sup> of molecules.

∴  $N_2$  &  $O_2$  gain energy by ~~convection~~ <sup>conduction</sup> where they collide with GHGs.

Tropospheric Lapse rate :-

Lapse rate =  $\frac{\text{Temp.}}{\text{Alt.}}$

Trop. lapse rate - Rate at which temp. ↓ with ↑ alt.



## \* Why does Lapse rate exist?

- Atmosphere is made of naturally compressible gases like  $N_2$  &  $O_2$ .  
 $N_2$  &  $O_2$  get compressed by the gravt. pull of earth,  
 & compression releases heat.  $\Rightarrow$  As we approach ground,  
 temp  $\uparrow$  & gets warm.

## \* Effective rad<sup>n</sup> Altitude

↳ The height beyond which the energy gets dissipated into the upper atmosphere.

This energy which escapes does so at a lower temp & therefore less energy escapes  $\Rightarrow$  More energy retained in the troposphere and therefore causes more warming.

$\therefore$  If effective rad<sup>n</sup> altitude  $\uparrow \Rightarrow$  Warming  $\uparrow$ .

## Are all GHGs the same?

- Do all GHGs have same effect?

Depends on

- 1) Conc<sup>n</sup> of the gas in atmos.
- 2) Lifetime of the gas molecules in the atmosphere.
- 3) The region of IR that gas absorbs & how much it absorbs.

## GHGs: A Closer Look

### Key Idea 1: Water Vapour (WP)

WP  $\Rightarrow$  Most abundant GHG in our atmosphere.

$\rightarrow$  Responsible for over half of earth's greenhouse forcing, helps in keeps the surface of Earth warm.



~~WV~~ WV Pressure:- WV content in atmosphere at any given moment.

If Vapour pressure ↑, gaseous water molecules ↑.  $\Rightarrow$  ↑ Temp.  
 $\rightarrow$  Retention of energy will be high.

## Carbon Dioxide

Keeling curve,  $\rightarrow$  we know about this

pH  $\rightarrow$  ↓ over the years in the ocean  $\Rightarrow$  Surface ocean water is acidic.

## Methane (Swamp gas, Marsh Gas)

$\rightarrow$  Natural Source & Biogenic Source

Methane conc. ↑ from 0.7 ppm to 1.7 ppm.

Global warming potential  $\rightarrow$  Change in radiative forcing by 1 kg of greenhouse gas to that of 1 kg  $\text{CO}_2$ .

$\rightarrow \text{CO}_2$ 's GWP is 1.

~~Rad~~ Radiative forcing - Change in balance b/w incoming & outgoing rad<sup>n</sup> of climate.

\* Methane ~~clathrate~~ clathrate:- As temp ↑, they have the potential to release stores of methane currently locked away in methane clathrate.

C stored in methane clathrates overall is 1 & 00 000 Gtaton.

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\*  $\text{N}_2\text{O}$  (Nitrous Oxide)

G, Gas - 300 times as large as  $\text{CO}_2$   
→ potent GHA.