CCI

→ Some parameters to represent earth atmospheric conditions :
1. Temp
2. Rainfall
3. humidity
4. solar rad

→ For short term → week time

→ Weather Vs Climate

Weather → short term data (max week)

Climate → long term atmospheric conditions

→ How our climate is changing ?
(or)
what components influencing our climate ?

1. Atmosphere
2. Ocean
3. Cryosphere [water in solid state, arctic, antarctic polar region
4. Biosphere [Living org]
5. Crust & Mantle → Volcanoes

→ Earth system components influencing climate

Due to changes in this components climate is also changing.

① **Earth's Atmosphere :-**

→ chemical composition :-

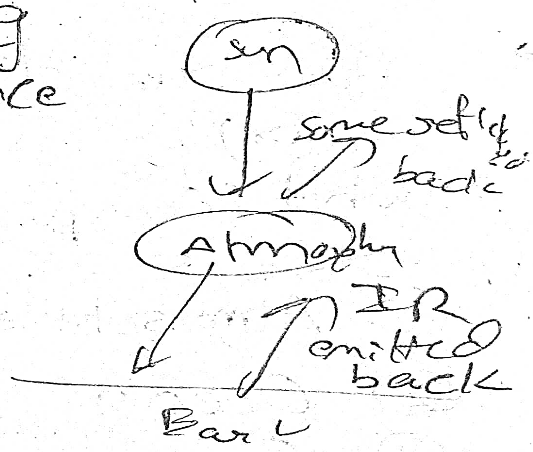
N_2	→	78%
O_2	→	21%
Ar	→	0.93%

water vapour → 0-5%
CO_2 - 380 ppm
O_3 → 0 - 0.1 ppm
if O_3 > 0.1 → injurie

→ IR reflected back from earth surface

→ H_2O (water vapour) absorbs IR radiation in atmosphere.

→ This causes warming effect due to presence of water vapour.



→ CO_2 also absorbs and causes warming effect and green house effect

→ SO_2 absorbs radiation and it reflects back to sun ⟶ cooling effect

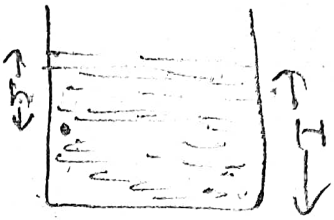
→ SO_2 comes from volcano eruption

Pressure :

$P = \omega h$

$P = \rho g h$

density of liquid (ρ)



surface

applies Force becuz of gravity $\Rightarrow F = ma$

underlying surface

$= Vol \times den \times g$

$F = \rho g$ (for 1 vol unit)

$$\text{Pressure} = \frac{F}{A} = \frac{\rho g}{1 \text{ unit area}} = \rho g$$

Pre from surface to upper P_s (in atm) $= \int_0^\infty \rho g \, dz$

$= g \int_0^\infty \rho \, dz$

$= g m \int_0^\infty dz$

$P_s = mg$

$m = P_s / g$ per m^2

$$M = \text{Area} \times m$$

Mass of earth

$$= 4\pi R^2 \times m$$

Excercise 1 :

→ The globally averaged surface pressure is 985 hPa. Estimate the mass of the atmosphere?

$$P_s = 985\,\text{hPa} = 985 \times 10^2\,\text{Pa}$$

$$m = \frac{P_s}{g} = \frac{985 \times 10^2}{9.81}$$

$$R = 6371\,\text{km}$$

$$M = \text{Area} \times m$$

$$= 4\pi R^2 \times \frac{985 \times 10^2}{9.81}$$

$$M = 5.1 \times 10^{18}\,\text{kg}$$

Vertical structure of atmosphere ÷

800 to 3000 Km	Exosphere
80-90 to 800 Km	Thermosphere
40-50 to 80-90 km	Mesosphere
11 to 50 km	Stratosphere
0 to 12-18 Km	Troposphere

Troposhere ÷

↓

turning/mixing

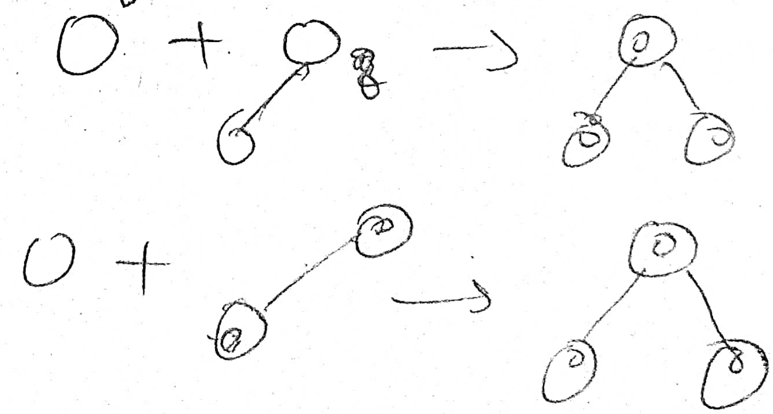
stratosphere ÷

Ozone formation ÷ → releases heat

step 1 ÷

$$O_2 + UV \rightarrow O + O$$

Step 2 ÷



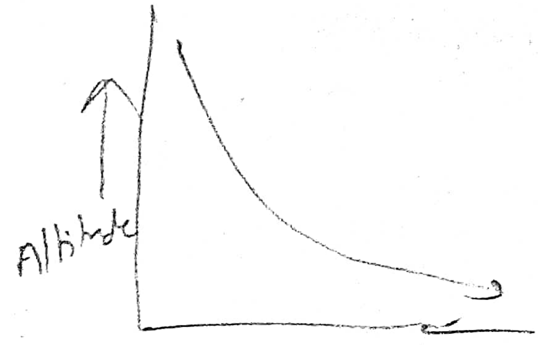
Mesosphere ÷ No reactions here

Thermosphere ÷

Air density & Pressure :

Air density = 1.25 kg/m3

$$\ln\left(\frac{P}{P_0}\right) = \frac{-z}{H}$$



P_0 → Pressure at sealevel

985 hPa or 1000 hPa

hecto pascal

P → unknown pressure

H → scale (height at which P becomes $\frac{1}{e}$ times P_0)

$$\boxed{z = H \ln\left(\frac{P_0}{P}\right)}$$

Excerise - 2 +

→ At approximately what height above sea level does half the mass of the atmosphere lie above and other half lie below? Assume an exponent pressure dependence with H = 8km.

$H = 8 \text{ km}$ $\quad P_0 = P_0$

$z = ?$ $\quad P = P_0/2$

$$z_{(P_0/2)} = 8 \ln\left(\frac{P_0}{P_0/2}\right) = 8 \ln 2$$

$$z = 5.545 \text{ km}$$

Excerise 3:- Assuming an exponential pressure and density dependence with H = 7.5km, estimate the heights in the atmosphere at which (a) the air density is equal to 1kg/m3 and (b) height at which the pressure is equal to 1hPa

$H = 7.5 \text{ km}$

$$z_{(P=1\text{kg/m}^3)} = 7.5 \ln\left(\frac{1.28}{1}\right) = 1.73 \text{ km}$$

$$z_{(P=1\text{hPa})} = 7.5 \ln\left(\frac{1000 \text{ hPa}}{1 \text{ hPa}}\right) = 51.8$$

2. Oceans

1. Artic
2. Atlantic
3. Pacific
4. Indian
5. Southern

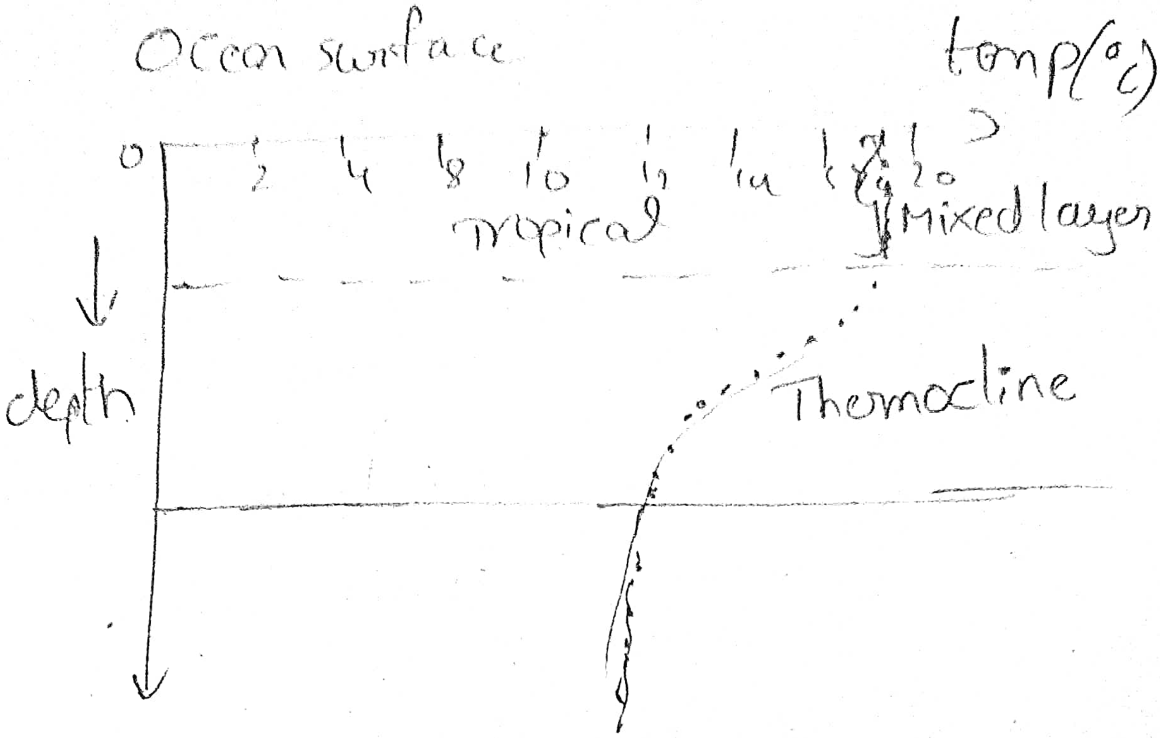
→ $\frac{2}{3}$rd earth covered by oceans

→ 11 km deep

→ Mariyana trench - pacific

→ Mass of ocean = 250 × Mass of atmosphere

Verticle structure



① Mixed layer → ① near surface
② wind movement

② Thermocline

Ocean circulation :-

① wind driven :- fast → velocity = 10 cm/s

② Thermohaline :- density driven → slow
→ 100 of years

3) Cryosphere : frozen (water in solid state)

→ influences Thermohaline

→ Permafrost : ground at 0°C for longer period 2yrs
frozen ground

→ Antarctic ice sheet : 2.5% earth surface

→ Alpine mountains : 0.1% earth

→ Greenland : 0.3 ~~05~~ % earth

→ Permafrost : 5% earth

what happens to sea level if all the cryosphere melts?

(1) Estimate how much the sea level would rise if the entire Arctic ice sheet were to melt.

Area covered by Arctic sea is 3% of the earth land area is 29.5% of earth. Earth radius 6371 km. mass of Arctic ice sheet = $0.04 \times 10^3 kg/m^2$

$m = vol \times density$

$m = area \times dep \times density$

$$0.04 \times 10^3 \times \frac{3}{100} \times 4\pi R^2 = \left(\frac{100 - 29.5}{100}\right) 4\pi R^2 \times x \times 10^3 kg/m^3$$

area of ocean

$x = 0.0017 m$

(2) Estimate how much if the entire permafrost were to melt. Area covered by permafrost ~~is~~ 5% of the area of the surface of the Earth, land area is 28.5% earth. Earth radius = 6371km, mass of ~~ice sheet~~ permafrost $10^3 kg/m$

$$\cancel{10^3} \times \frac{5}{\cancel{100}} \times \cancel{4\pi R^2} = \left(\frac{100 - 28.5}{\cancel{100}}\right) \cancel{4\pi R^2} \times x \times \cancel{10^3} kg/m^3$$

$$x = \frac{5}{71.5} = 0.069$$

(4) Biosphere :-

→ living + non living
biota abiotic

(5) Earth's crust and mantle :-

volcanoes → SO_2
reflect radiation

Two important cycles influencing earth's climate

(1) Hydrologic cycle (2) Carbon cycle

(1)

Precipitation / Rainfall / Snow :-

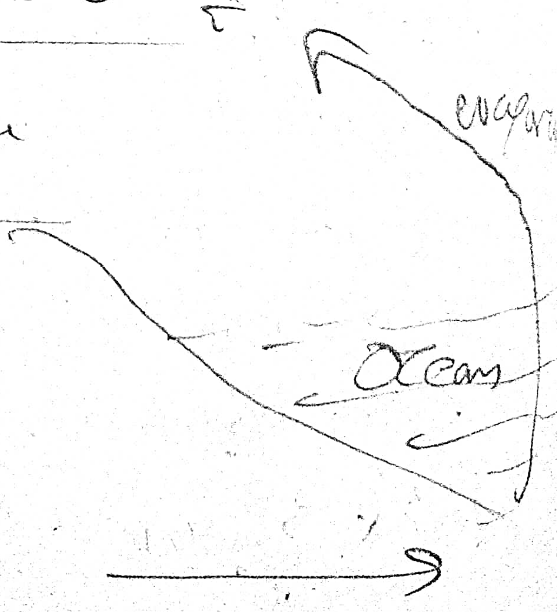
↓ reaches earth surface

Earth surf

infiltration ↓ soil

percolation ↓ deep

seepage →



From vegitation → Transpiration

From Oceans → Evaporation

2) <u>Carbon cycle</u> :

Atm

↓ photosynthes   atmos

↓

Biosphere

↓ bury

Crust → weathering action   long time

Carbo