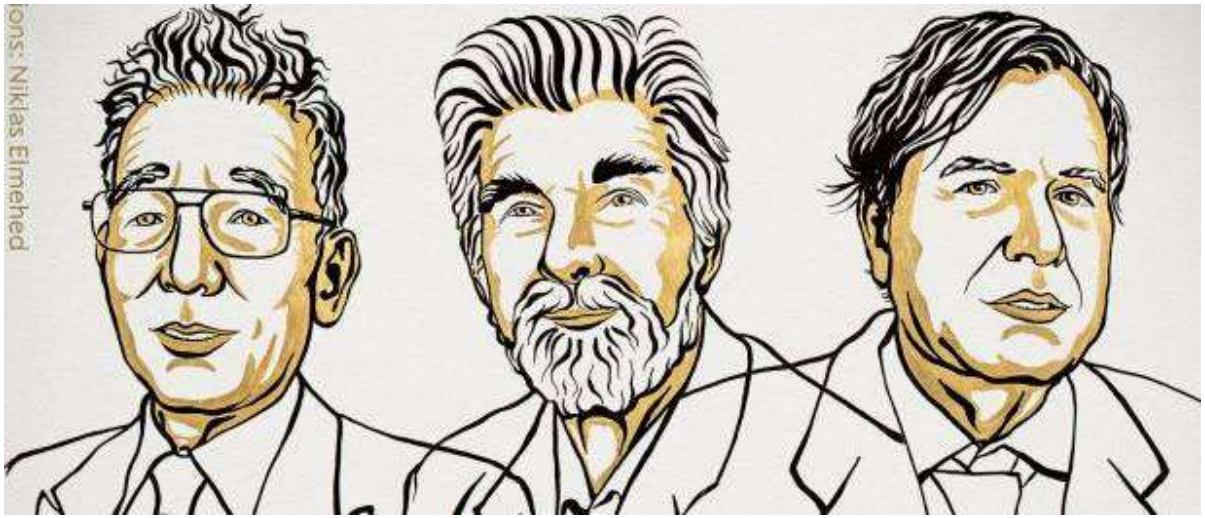
Climate change and its implications

Dr. Raji P

(raji.p@iiits.in)

Lecture-1



Syukuro Manabe Klaus Hasselmann Giorgio Parisi

Course outline: 2 credit

- Introduction to climate & climate change
- Evidence of climate change
- Global climate models & future climate projections
- Implications to
  : Biodiversity, mitigation practices
  : Agriculture, mitigation practices
  : Water resources, mitigation practices

QGIS-Quantum GIS

https://qgis.org/en/site/

Tinn R

Class outline:

Earth system Components

- Atmosphere
- Oceans
- Cryosphere
- Biosphere
- Earth’s crust and mantle

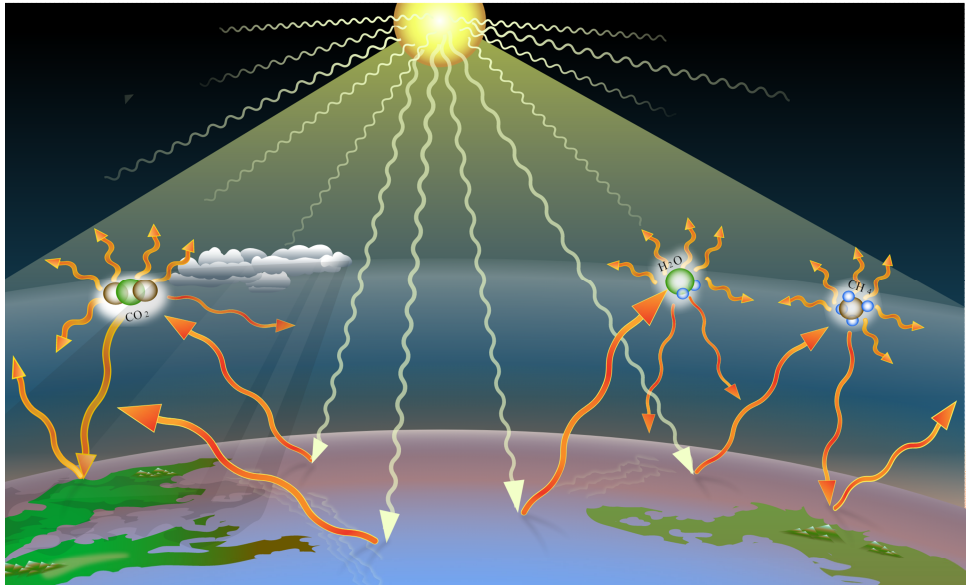
Class outline:

Earth system Components: 1) Atmosphere

Characteristics of Earth's atmosphere

- Optical properties
- Mass
- Composition
- Vertical structure: temperature, general circulations

Optical properties



- Earth's atmosphere is transparent to incoming solar radiation
- The outgoing radiation emitted by Earth is absorbed by the atmosphere (green house effect), and this makes the Earth's atmosphere warm
- About 22% of incoming solar rad is backscattered to space without absorption

Mass of the atmosphere

Mass of the atmosphere

- At any point on the earth's surface, the atmosphere exerts a downward force on the underlying surface due to earth's gravitational attraction.
- The downward force (i.e., the weight) of a unit volume of air with density ρ is given by,

  $F = \rho g$

  Where g is the acceleration due to gravity.
- Integrating the equ from earth's surface to the top of the atmosphere, we obtain the atmospheric pressure on the earth's surface (Ps) due to the weight (per unit area) of the air in the overlying column.

  i.e., $Ps=\int_0^\infty \rho g \, dz$
- Neglect the small variation of g with lat, long, and height, we can take the mean value g, which is equal to 9.807 m^2/s, we can take it outside the integral.

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

which is again equal to = g m

where m is the vertically integrated **mass per unit area of the overlying air**

Exercise 1

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

Earth's radius=6.37×10^6 m

Chemical composition

Constituent[a]	Molecular weight	Fractional concentration by volume
Nitrogen (N_2)	28.013	78.08%
Oxygen (O_2)	32.000	20.95%
Argon (Ar)	39.95	0.93%
Water vapor (H_2O)	18.02	0–5%
Carbon dioxide (CO_2)	44.01	380 ppm
Neon (Ne)	20.18	18 ppm
Helium (He)	4.00	5 ppm
Methane (CH_4)	16.04	1.75 ppm
Krypton (Kr)	83.80	1 ppm
Hydrogen (H_2)	2.02	0.5 ppm
Nitrous oxide (N_2O)	56.03	0.3 ppm
Ozone (O_3)	48.00	0–0.1 ppm

- Water vapour accounts for 0.25% of the mass of the atmosphere

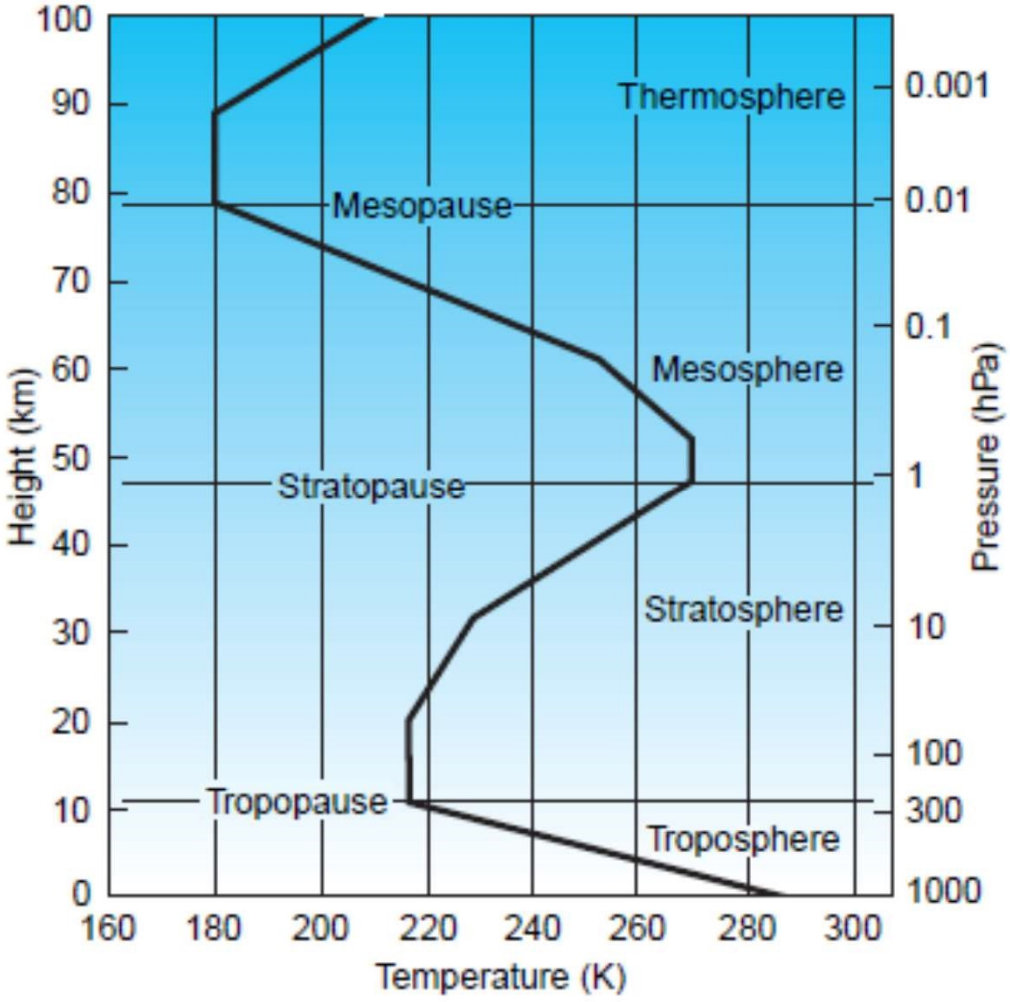
- Exposure to ozone concentration>0.1 ppmv is considered hazardous to human health

- Gas molecules with certain structures are highly effective in trapping outgoing radiation and are called green house gases

  eg. CH4, N_2O, CO, and chloroflurocarbons (CFCs) – enter into the atmosphere via burning of plant matter, fossil fuels, emission from plants, decay of plants and animals etc.

Vertical structure of atmosphere

Vertical structure



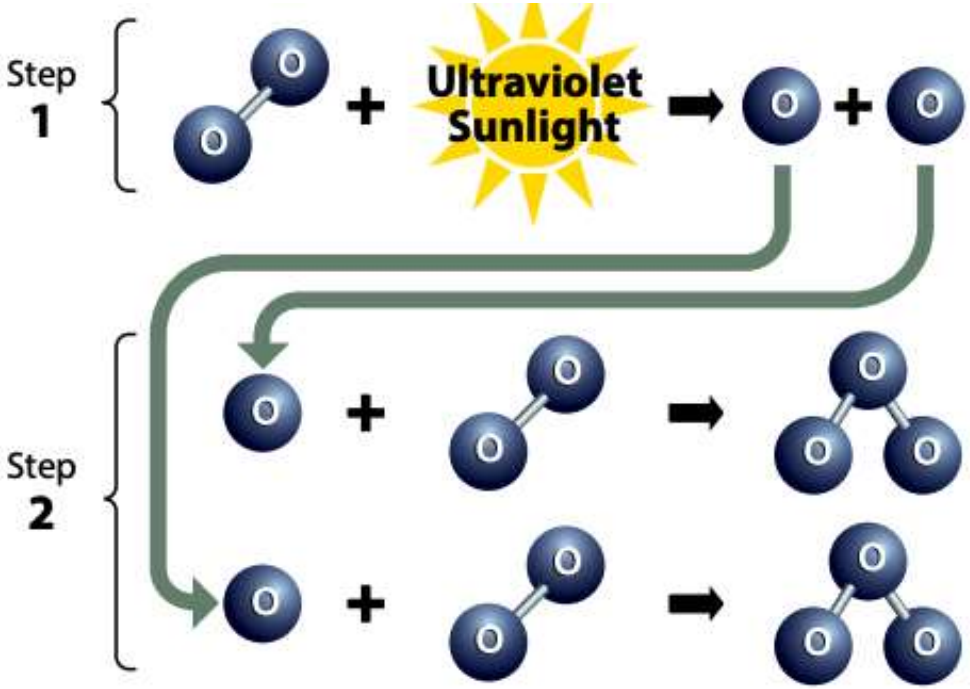
- Tropo-(turning or changing/vertical mixing) -sphere
- Temperature decreases with height (~6.5°C)
- Troposheric air accounts for the 80% of the mass of the atmosphere

---

- Strato-(layered)-sphere, vertical mixing is prohibited due to the increase of temp with height
- Residence time of particles are longer
- Air is extremely dry and ozone rich
- They absorb the UV from the spectrum
- This increases the temperature

- Meso-(inbetween)-sphere: temperature decreases with height

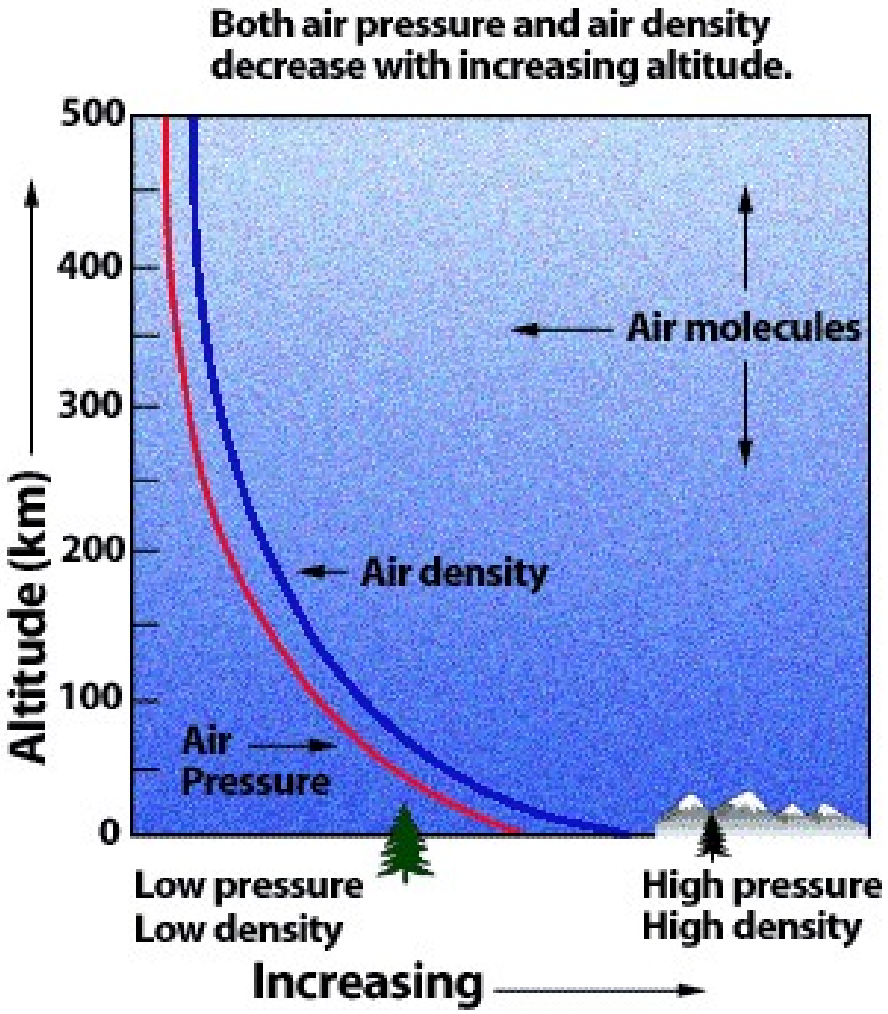
- Thermosphere-temp increases with height due to the absorption of solar rad, and lots of ionization processes occurs



Ozone formation in stratosphere

Anvil cloud (Cloud flattening) at the tropopause

- All the weather and climate activities are under the tropopause



Density of air @ sea level is 1.25 kg/m^3

Pressure at any height:

$$p \simeq p_0 e^{-z/H}$$

P_0 is the pressure @ sea level (reference level)

H- scale height; e-folding depth (height at which pressure becomes 1/e times p_0), 7 to 8 Km

$$\ln \frac{p}{p_0} \simeq -\frac{z}{H}$$

$$z = H \ln(p_0/p)$$