SNS COLLEGE OF TECHNOLOGY
(An Autonomous Institution)

Department of Aerospace Engineering

23AST101-Fundamentals of Aerospace Engineering

UNIT-4:
POWER PLANTS

Study of Atmosphere

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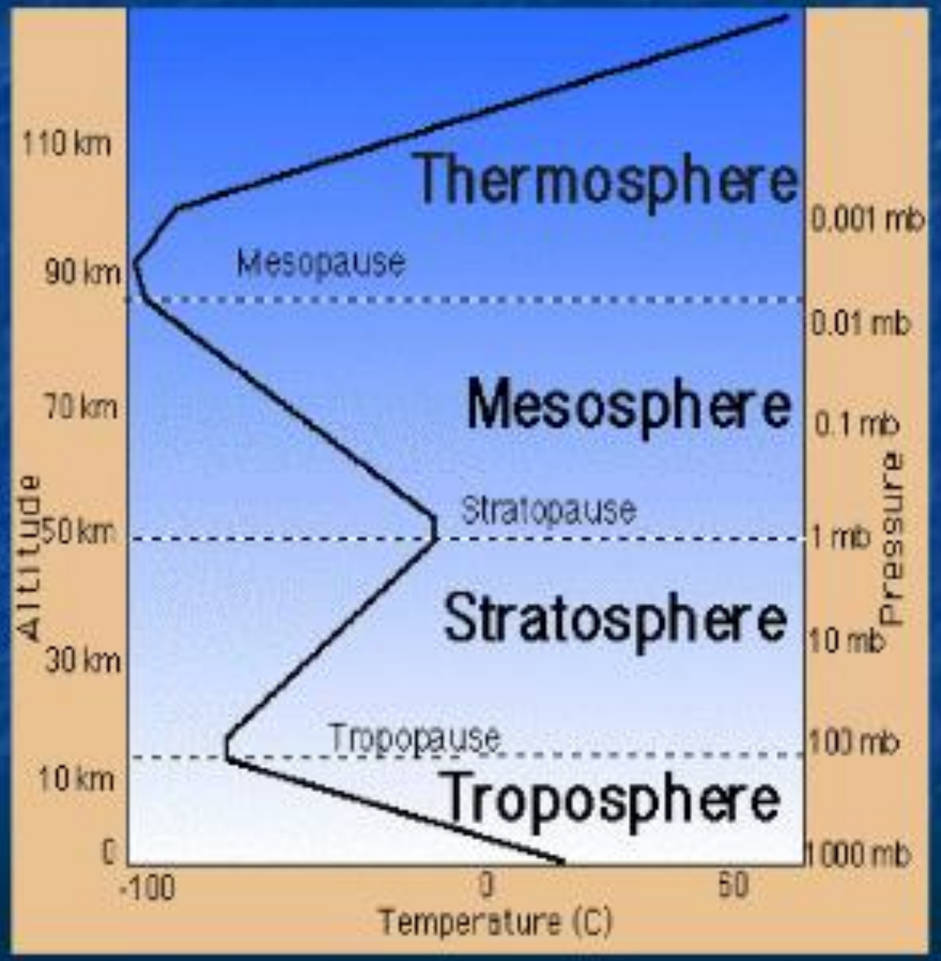
Vertical structure of the atmosphere



The atmosphere is divided into **four** isothermal layers or 'spheres': **troposphere, stratosphere, mesosphere and thermosphere.**

Each layer is characterised by a uniform change in temperature with increasing altitude.

In some layers there is an increase in temperature with altitude, whilst in others it decreases with increasing altitude.

The top or boundary of each layer is denoted by a 'pause' where the temperature profile abruptly changes.

Troposphere

The troposphere contains about **80%** of the atmosphere and is the part of the atmosphere in which we live, and make weather observations.

In this layer, average temperatures decrease with height 6.4°c/1000m, as there is less air in contact with the ground to heat up. This is known as **Environmental Lapse rate** (adiabatic cooling brought about by changes in temperature caused by a decrease in pressure at height).

This sphere mixes vertically by convection, conduction and turbulence more than any other sphere. These vertical motions and the abundance of water vapour make it the home of all important weather phenomena.

The troposphere is around **16 km high** at the equator, with the temperature at the tropopause around -80 °C. At the poles, the troposphere reaches a height of around 8 km, with the temperature of the tropopause around -40 °C in summer and -60 °C in winter. Therefore, despite the higher surface temperatures, the tropical tropopause is much cooler than at the poles at the thickness is increased - more cooling occurs.

Stratosphere

Temperatures in the stratosphere rise with increasing altitude (creating a temperature inversion) this is caused by concentrations on O_3 which absorbs ultraviolet radiation. This is greatest around 50 km at the edge of the stratopause. Temperatures range from -30 °C over the winter pole to +20 °C over the summer pole according to latitude and season.

As well as a noticeable change in temperature, the move from the troposphere into the stratosphere is also marked by an abrupt change in the concentrations of the variable trace elements. Water vapour decreases sharply, whilst ozone concentrations increase. These strong contrasts in concentrations are a reflection of little mixing between the moist, ozone-poor troposphere and the dry, ozone-rich stratosphere.

The stratosphere extends up to around 48 km above the surface, and together with the troposphere, they account for 99.9% of the Earth's atmosphere.

Mesosphere

Temperatures in the mesosphere decrease rapidly as there is no water vapour, cloud, dust or ozone to absorb incoming radiation.

Temperatures at the mesopause go as low as -120 °C with very strong winds - 3000km/hr.

As in the troposphere, the unstable profile means that vertical motions are not inhibited. During the summer, there is enough lifting to produce clouds in the upper mesosphere at high latitudes

Thermosphere

The thermosphere extends upwards to altitudes of several hundred kilometres, where temperatures range from 250°c to as high as 1,700°c, getting warmer with increasing height.

Temperature ranges depend on the degree of solar activity and as there is more atomic oxygen there (like ozone) to absorb the heat.

The temperature changes between day and night (**Diurnal**) amount to hundreds of degrees.

Above 500 km temperatures are very difficult to define. Molecules are so widely spaced that they move independently, and there is no reason why their temperatures should be the same.

Composition of the Atmosphere

- **Nitrogen (N_2)** – ~78%
- **Oxygen (O_2)** – ~21%
- **Argon (Ar)** – ~0.93%
- **Carbon Dioxide (CO_2)** – ~0.04% (varies)
- **Other gases** – Trace amounts (neon, helium, methane, etc.)
- **Water vapor** – 0–4% depending on location and weather

Importance of the Atmosphere

- Protects from harmful solar radiation (UV).
- Moderates Earth's temperature via the greenhouse effect.
- Enables respiration and supports life.
- Facilitates weather and climate patterns.
- Acts as a medium for sound propagation.

Fields Involved in Atmospheric Studies

- **Meteorology** – Study of weather and atmospheric conditions.
- **Climatology** – Study of climate and long-term atmospheric trends.
- **Atmospheric Chemistry** – Focuses on chemical composition and reactions.
- **Aeronomy** – Study of upper atmospheric layers (thermosphere/exosphere).

Tools and Techniques

- **Weather balloons** (radiosondes)
- **Satellites** (e.g., GOES, METEOSAT)
- **Doppler radar**
- **Remote sensing**
- **Computational models** for forecasting


THANK YOU!