Books and other details

- ✓ **Principles of environmental chemistry / James E. Girard.**
- ✓ **Environmental chemistry / Stanley E. Manahan.**
- ✓ **Basic concepts of environmental chemistry / Des W. Connell.**
- ✓ **Fundamentals of Environmental / Stanley E. Manahan.**
- ✓ **Chemistry Boca Raton: CRC Press LLC, 2001**
- ✓ **NPTEL Online courses**

- ✓ Pictures are copied from various webpages and Google

Course contents

- ✓ Understanding our environment
  - atmosphere composition and behaviour, ecosystem, flow of energy and nutrient cycles, sustainability
- ✓ Brief overviews of ozone depletion and atmospheric pollutants
- ✓ Global warming
  - greenhouse gases, results of global warming
- ✓ Organic and Inorganic chemicals in environment
  - toxicity, polychlorinated hydrocarbons like DDT, polymers, detergents
  - their impact on environment
- ✓ A project on environment related topic

States of Matter in the Environment

- ✓ Gas
  - Atmosphere
- ✓ Liquid
  - Oceans, Lakes and Rivers
- ✓ Solid
  - Soil, Rocks and so on

Gas – Atmosphere of Earth

- ✓ An atmosphere is a layer or a set of layers of gases surrounding a planet or other material body, that is held in place by the gravity of that body

- ✓ 99% of atmospheric gases, including water vapor, extend only 30 kilometers (kms) above earth's surface.

- ✓ Most of our weather, however, occurs within the first 10 to 15 kms.

- ✓ Composition of Atmosphere
  - Nitrogen – 78%
  - Oxygen – 21%
  - Carbon Dioxide – 0.038%
  - Other gases make up the rest

  - Water Vapor – 0 to 4%

Greek:
Atmos meaning Vapour;
Sphaira meaning sphere

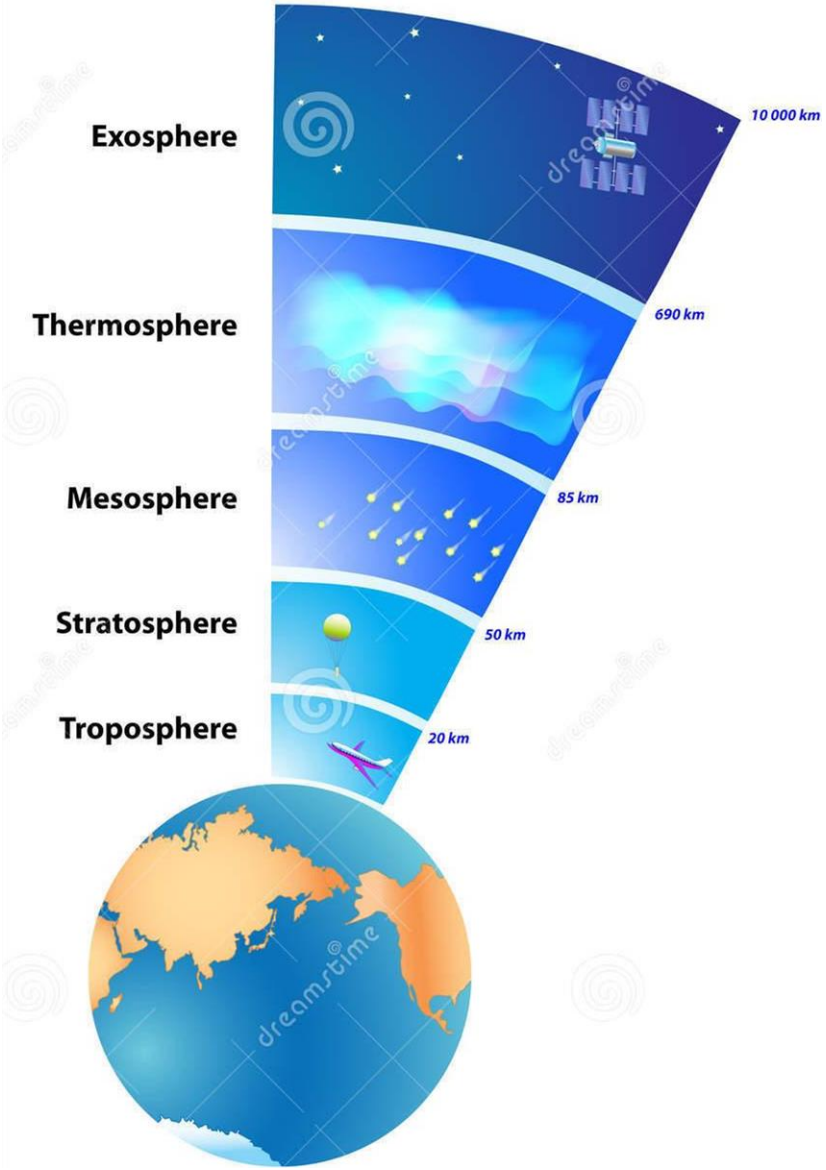
Atmosphere of Earth

- ✓ Temperature Inversion
  - An increase in air temperature with height often called simply an inversion.

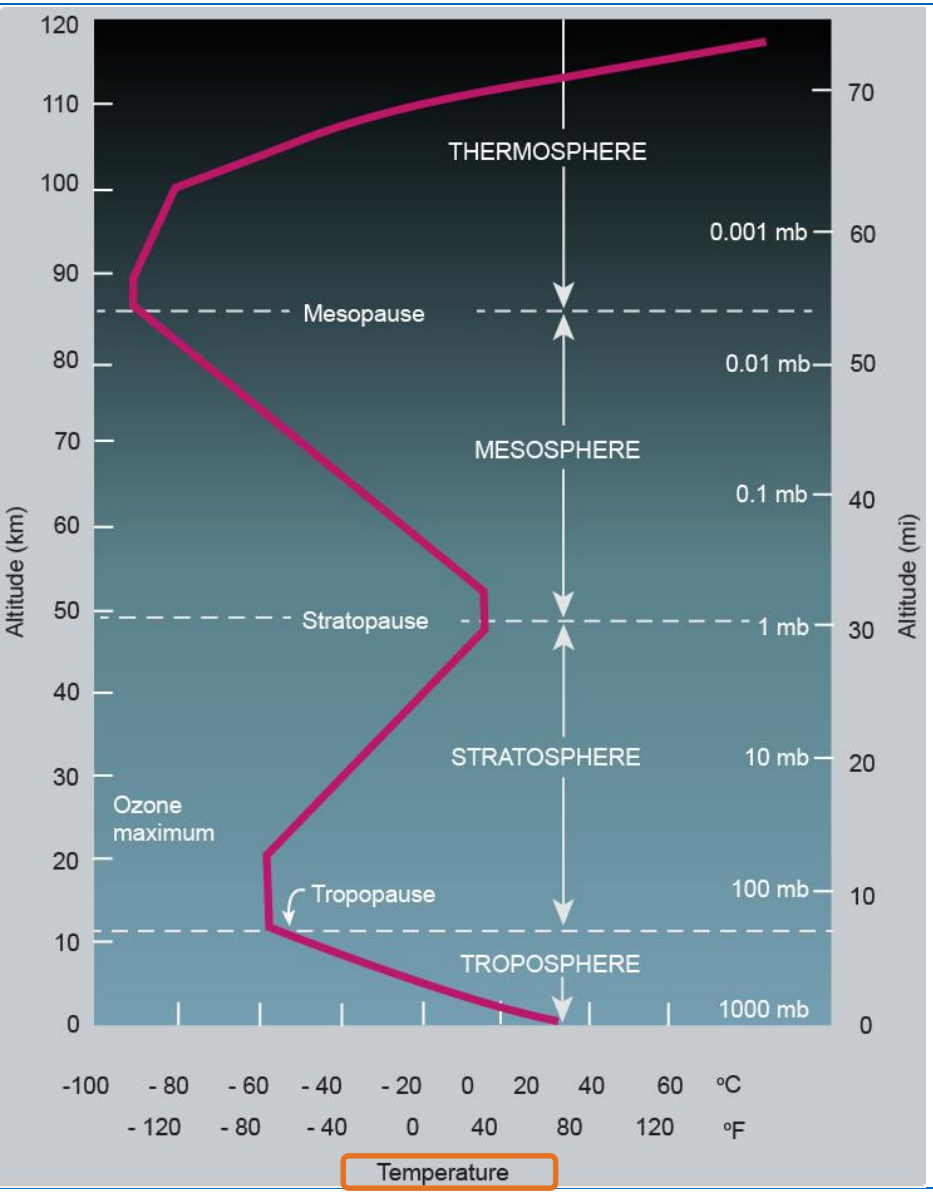
- ✓ Radiosonde – an instrument that measures the vertical profile of air temperature in the atmosphere (sometimes exceeding 100,000 ft (or) ~ 30 kms)

- ✓ Commercial flights fly between 31,000 ft to 38,000 ft (or) ~ 9.5 to 11.5 kms

Earth’s atmosphere: Layers

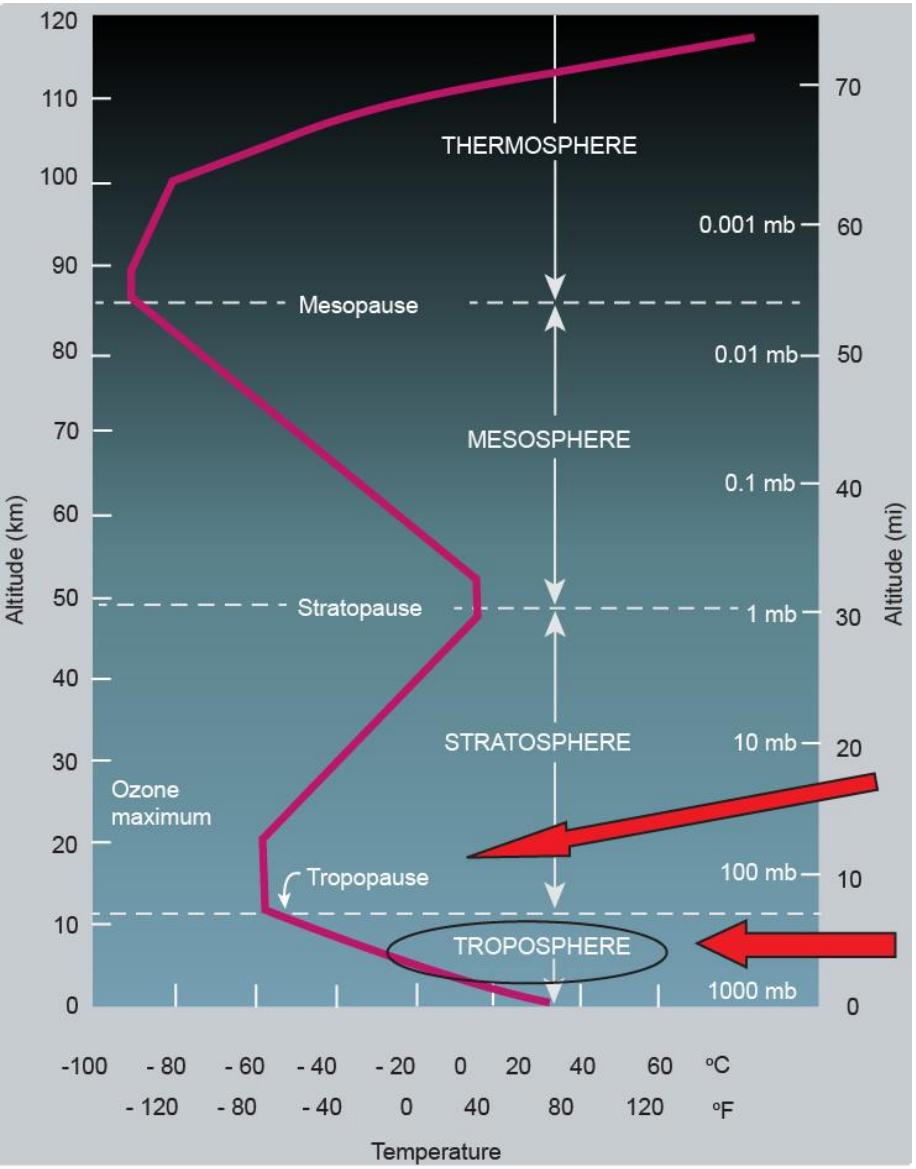


Atmosphere of Earth



- ✓ 8 layers are defined by constant trends in average air temperature (which changes with pressure and radiation), where the outer exosphere is not shown.
  1. Troposphere
  2. Tropopause
  3. Stratosphere
  4. Stratopause
  5. Mesosphere
  6. Mesopause
  7. Thermosphere
  8. Exosphere

Atmosphere of Earth



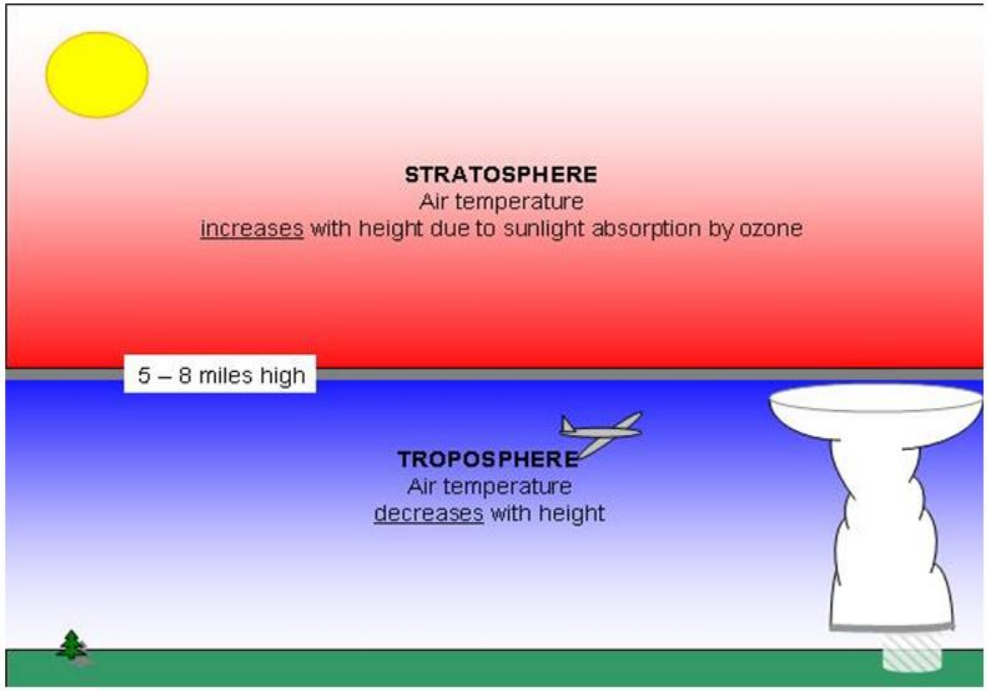
- ✓ Lower part of Troposphere (**0-3** kms), is called **Boundary Layer**.
- ✓ All the pollutants are present in this layer

Tropopause separates Troposphere from Stratosphere. Generally higher in summer Lower in winter.

Troposphere – temperature decreases with height. Most of our weather occurs in this layer varies in height around the globe, but Averages of about 11 km in height.

Troposphere

- ✓ The troposphere is the lowest major atmospheric layer, followed by Stratosphere
- ✓ The troposphere is where all of Earth's weather occurs
- ✓ Troposphere itself doesn't efficiently absorb solar radiation
- ✓ It has decreasing temperature with height 6.5 °C per kilometer
- ✓ Lowest temperature of Troposphere is -57 °C
- ✓ Helps to freeze the water vapour as ice crystals that fall back to the surface of the earth

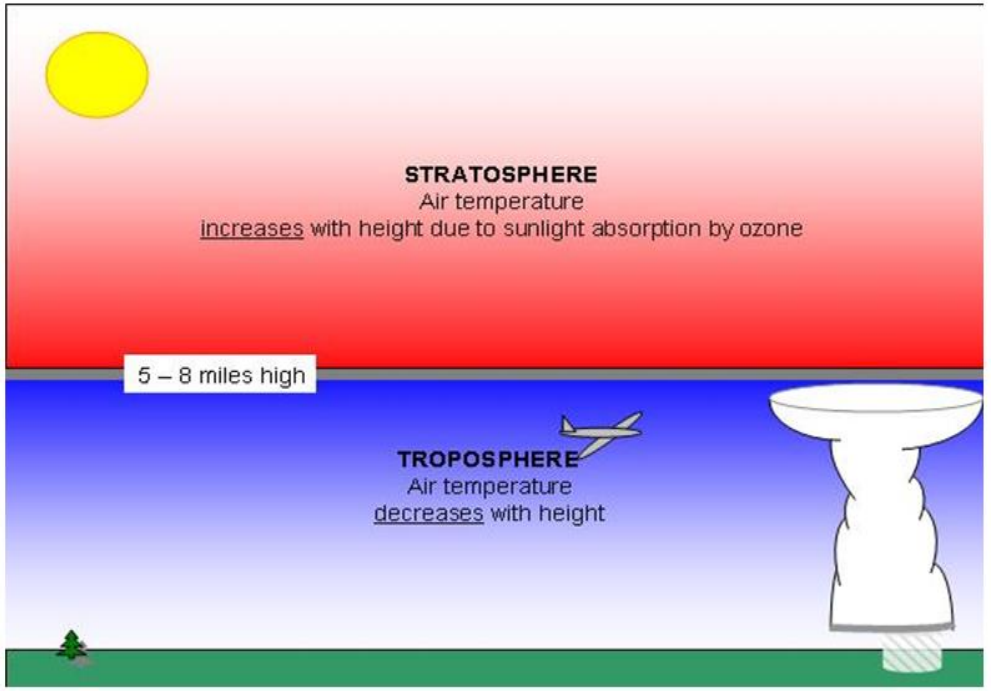


Tropopause

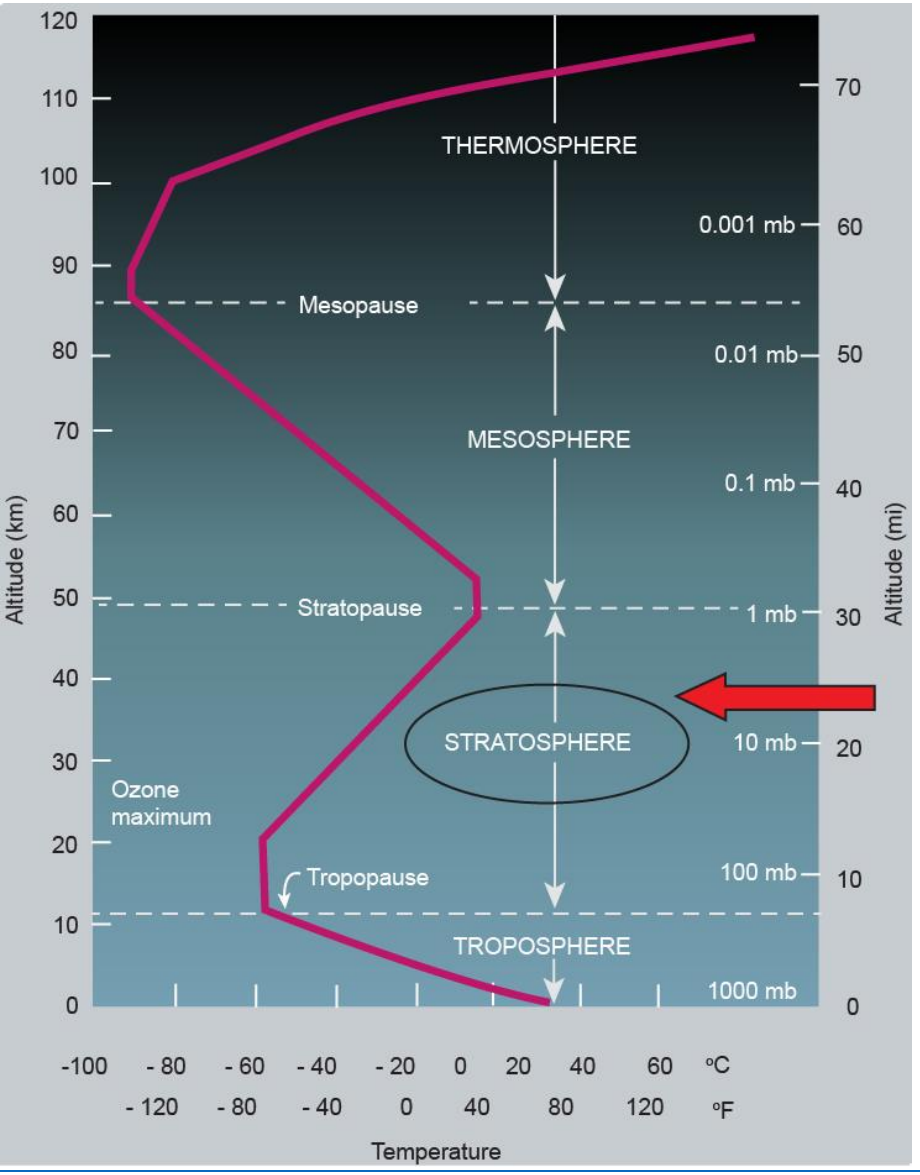
- ✓ The boundary that divides the troposphere from the stratosphere is called the **"Tropopause"**
  - Located at an altitude of around
    - ~8 kms in the winter
    - ~13 kms high in the summer
    - ~17 or 19 kms in the deep tropics

16 Km thick at Equator,
9 Km thick at poles.

- ✓ When you see the top of a thunderstorm flatten out into an anvil cloud, like in the illustration, it is usually because the updrafts in the storm are **"bumping up against"** the bottom of the stratosphere



Stratosphere



- ✓ It is present at ~17 – 50 kms from earth surface
- ✓ It includes Ozone layer
- ✓ About 20% of the atmosphere's mass is contained in the stratosphere
- ✓ Stratosphere has either constant or slowly increasing temperature with height.
- ✓ Max. temp. is –1°C
- ✓ Ozone absorbs UV irradiation & converts into heat.

Temperature inversion in stratosphere

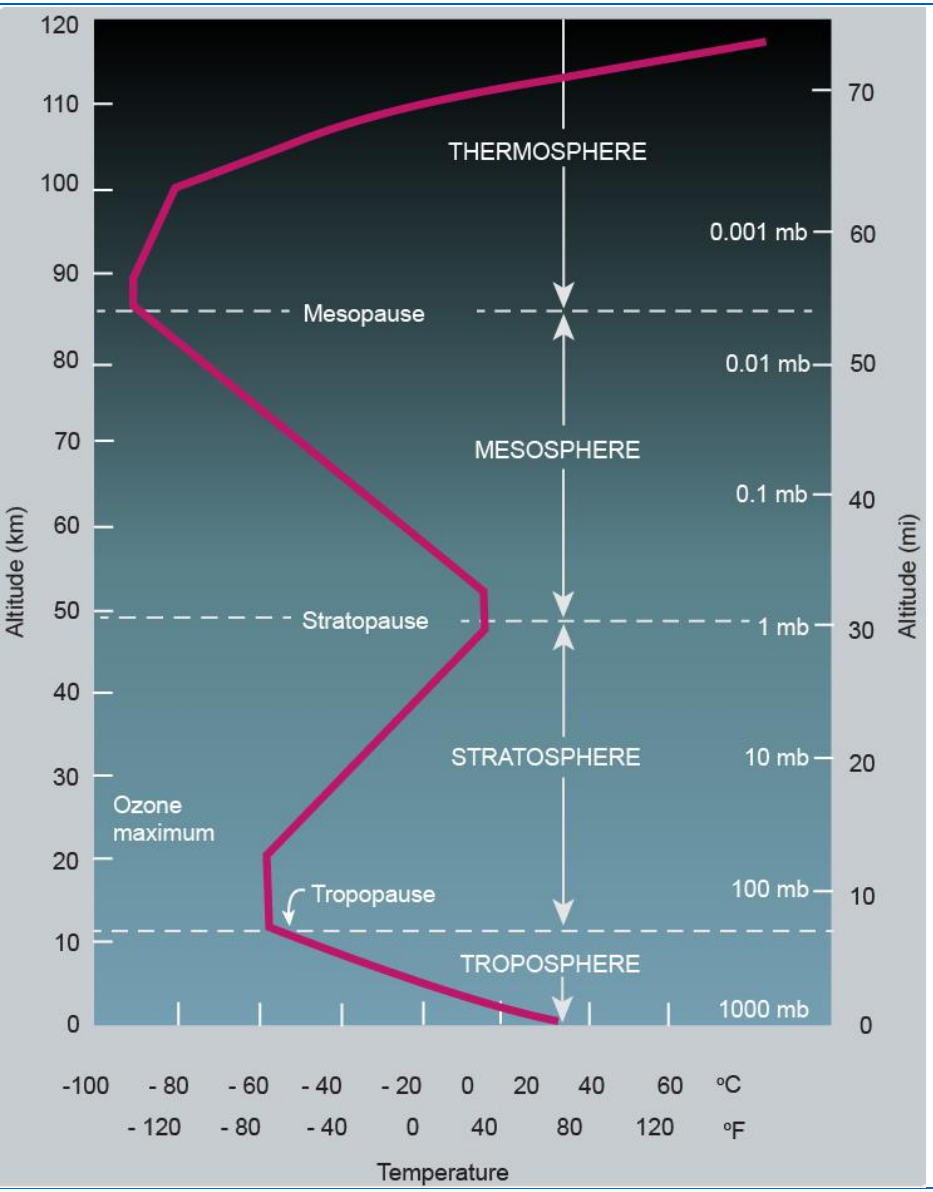
Ozone plays a major part in heating the air at this altitude

Troposphere + Stratosphere => Lower atmosphere

Stratosphere and Ozone Layer

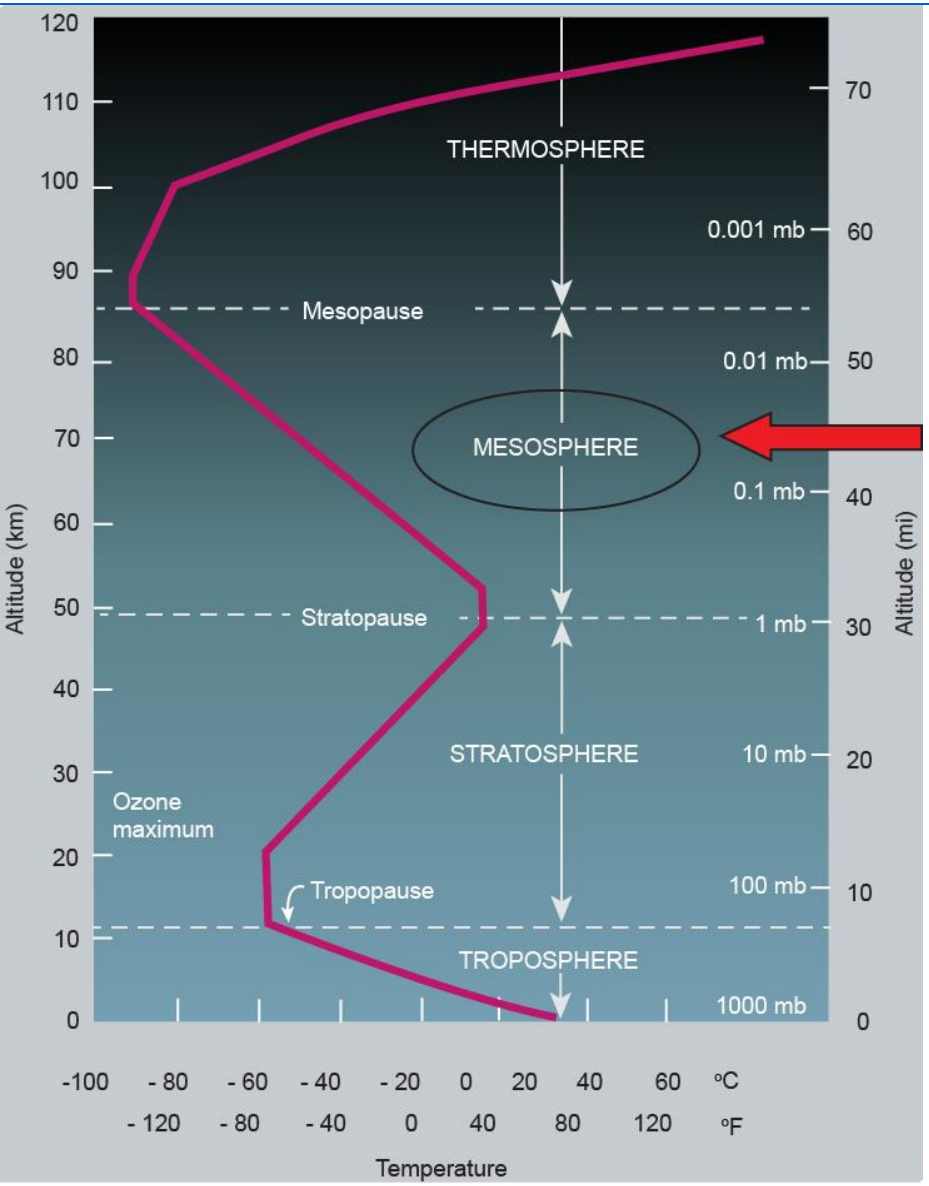
- ✓Air flow in Stratosphere is mostly horizontal.
- ✓The thin ozone layer in the upper stratosphere has a high concentration of ozone, a particularly reactive form of oxygen.
- ✓This layer is primarily responsible for absorbing the ultraviolet radiation from the Sun.
- ✓The formation of this layer is a delicate matter, since as only when oxygen is produced in the atmosphere the ozone layer can form and prevent an intense flux of ultraviolet radiation from reaching the surface, where it is quite hazardous to the evolution of life.
- ✓There is considerable recent concern that manmade **flourocarbon** compounds may be depleting the ozone layer, with dire future consequences for life on the Earth.

Mesosphere and Ionosphere



- ✓Above the stratosphere is the mesosphere and above that is the ionosphere (or thermosphere), where many atoms are ionized (have gained or lost electrons so they have a net electrical charge).

Mesosphere

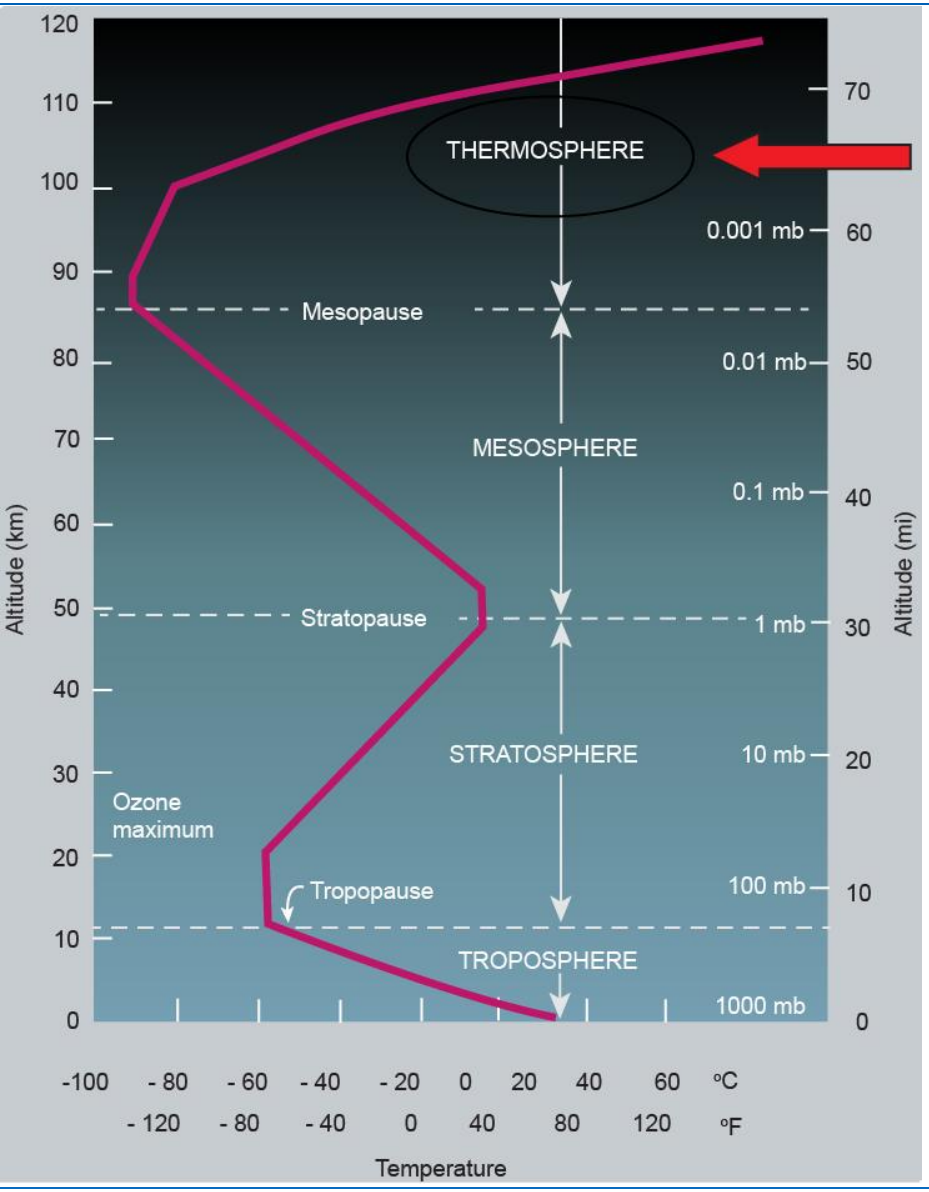


- ✓ Mesosphere: ~ 50-90 kms
- ✓ Temperature falls again in mesosphere
- ✓ Lowest temperature is ~ –90 °C (lowest temperature in whole atmosphere)

Middle atmosphere

- ✓ Very thin air with low pressure
- ✓ Needs Oxygen to live in this region

Thermosphere (or) Ionosphere



"Hot layer"

- ✓ Very few atoms and molecules in this Region.
- ✓ Temperature raises again in this region
- ✓ Due to reaction between high energy radiation emanating from Sun and few gas molecules
- ✓ Max. temperature: ~1200 °C

Thermosphere (or) Ionosphere

- ✓The ionosphere is very thin, but it is where aurora take place
  - Charged particles from space collide with atoms and molecules in the thermosphere, exciting them into higher states of energy.
  - The atoms shed this excess energy by emitting photons of light, which we see as the colorful **Aurora Borealis** and **Aurora Australis**.

- ✓It's responsible for absorbing the most energetic photons from the Sun
- ✓Also responsible for reflecting radio waves, thereby making long-distance radio communication possible

- ✓In thermosphere the space shuttles fly and the International Space Station orbits Earth.