The atmospheric classifications

Textbooks and web sites references for this lecture:

- A. Longhetto – Dispense di Fisica dell'atmosfera
- Physic der atmosphäre - Institut für Umweltphysik - Universität Heidelberg
- Peter Lynch - The Composition and Structure of the Atmosphere - Meteorology & Climate Centre, School of Mathematical Sciences, University College Dublin

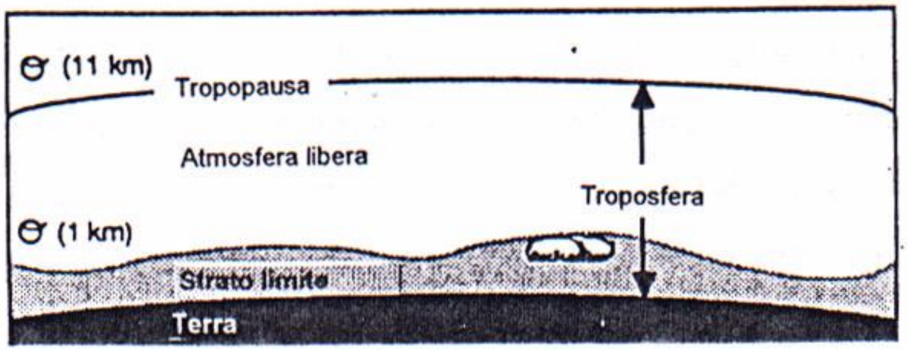
Classifications (1)

based on the interactions with terrestrial surface

- "We can define the boundary layer as **that part of the troposphere that is directly influenced by the presence of the earth's surface, and responds to surface forcings with a timescale of an hour or less**." (Stull, 1988)

- These forcings include:
  - frictional drag
  - evaporation and transpiration
  - heat transfer
  - pollutant emission
  - terrain-induced flow modifications

- ***Planetary boundary layer*** (0-1500 m) is the layer directly affected by processes occurring at the surface, where turbulence and friction dominate;
- ***Free atmosphere*** (≥ 1500 m) is the layer not directly affected by surface processes, where Coriolis force effect dominates



Classifications (2)

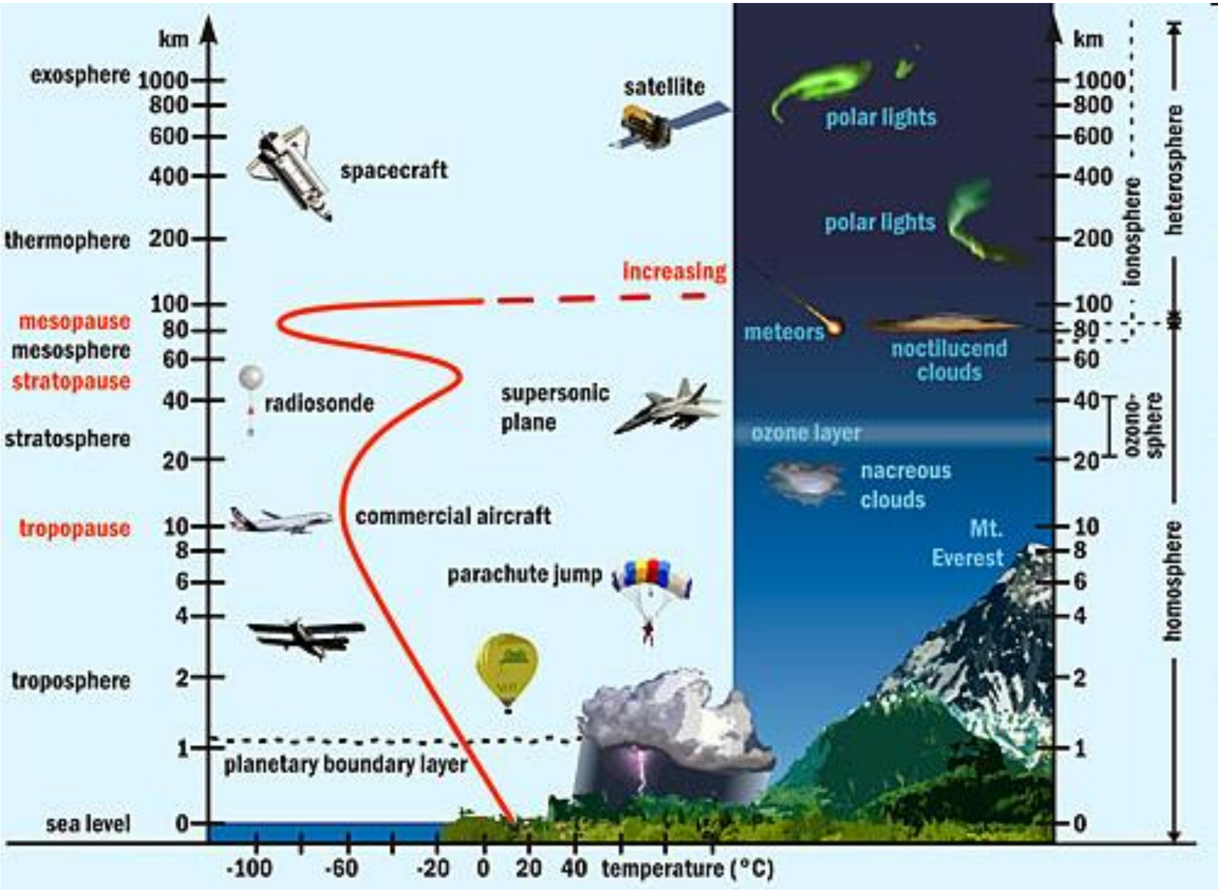
Based on chemical composition

- ***Omosphere*** (0÷95 km):

  concentrations does not vary with quote;

- ***Eterosphere*** (≥ 95 km):

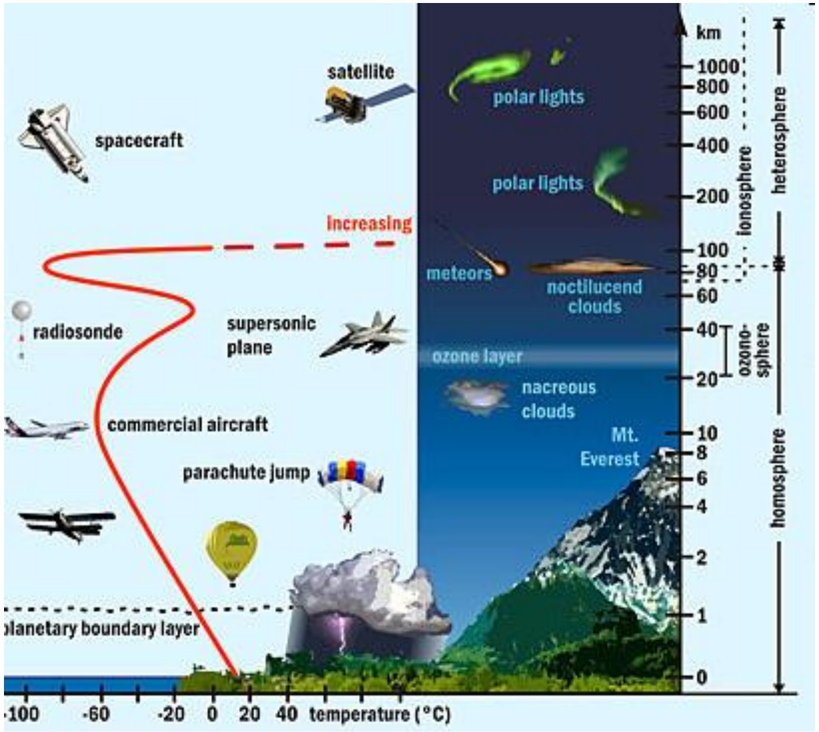
  the compounds are at atomic state and their concentration is strongly depending on the quote (stratification);

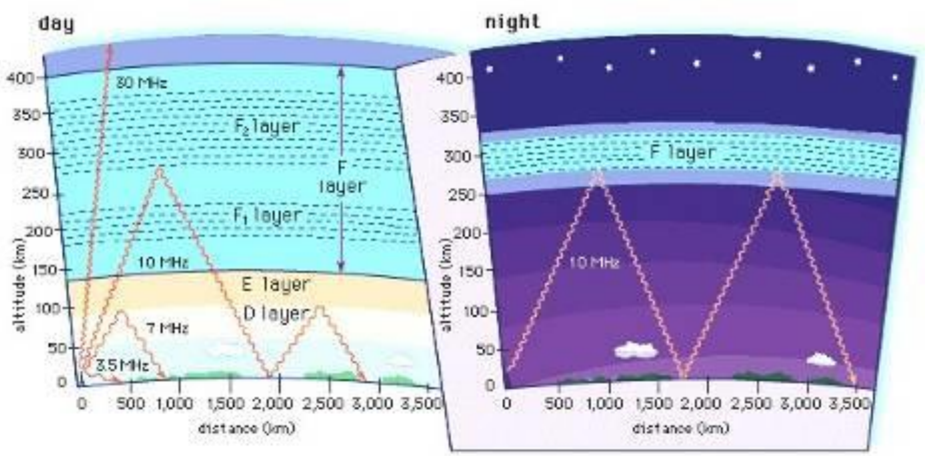


Classifications (3)

Based on the Degree of Ionisation

- ***Neutrosphere*** (0÷70 km): low ion density;
- ***Ionosphere*** (≥ 70÷400 km): the compounds are at atomic state and their concentration is strongly depending on the quote (stratification);





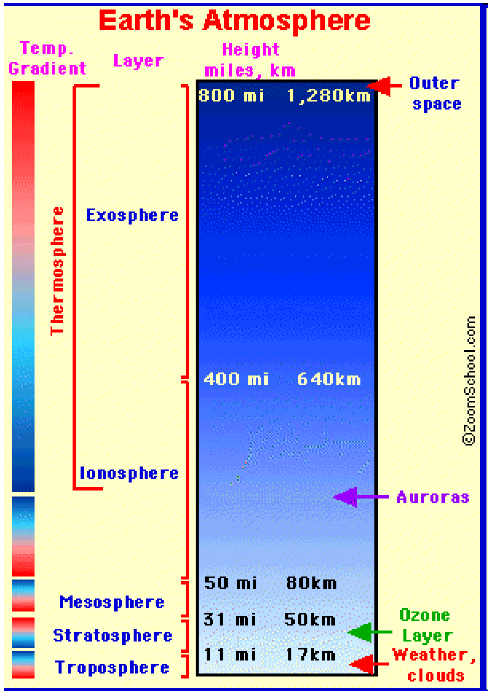
- ***ionosphere*** (located inside the eterosphere, 70÷400 Km): particles are ionized and affect the propagation of radio waves; specific ionization conditions vary greatly between day (left) and night (right), causing radio waves to reflect off different layers of the ionosphere or transmit through them, depending upon their frequency and their angle of transmission

Classifications (4)

- The atmosphere can be divided up according to pressure (500 mb layer is about halfway up in the atmosphere).
- The atmosphere can also be divided up according to temperature (which does not follow a simple relationship with height) in individual layers –similar to the floors of a building. Customary divisions follow pertinent physical properties of the atmospheric layers
- Averaging out temperature values in the atmosphere, we identify four layers.

Atmospheric Layers

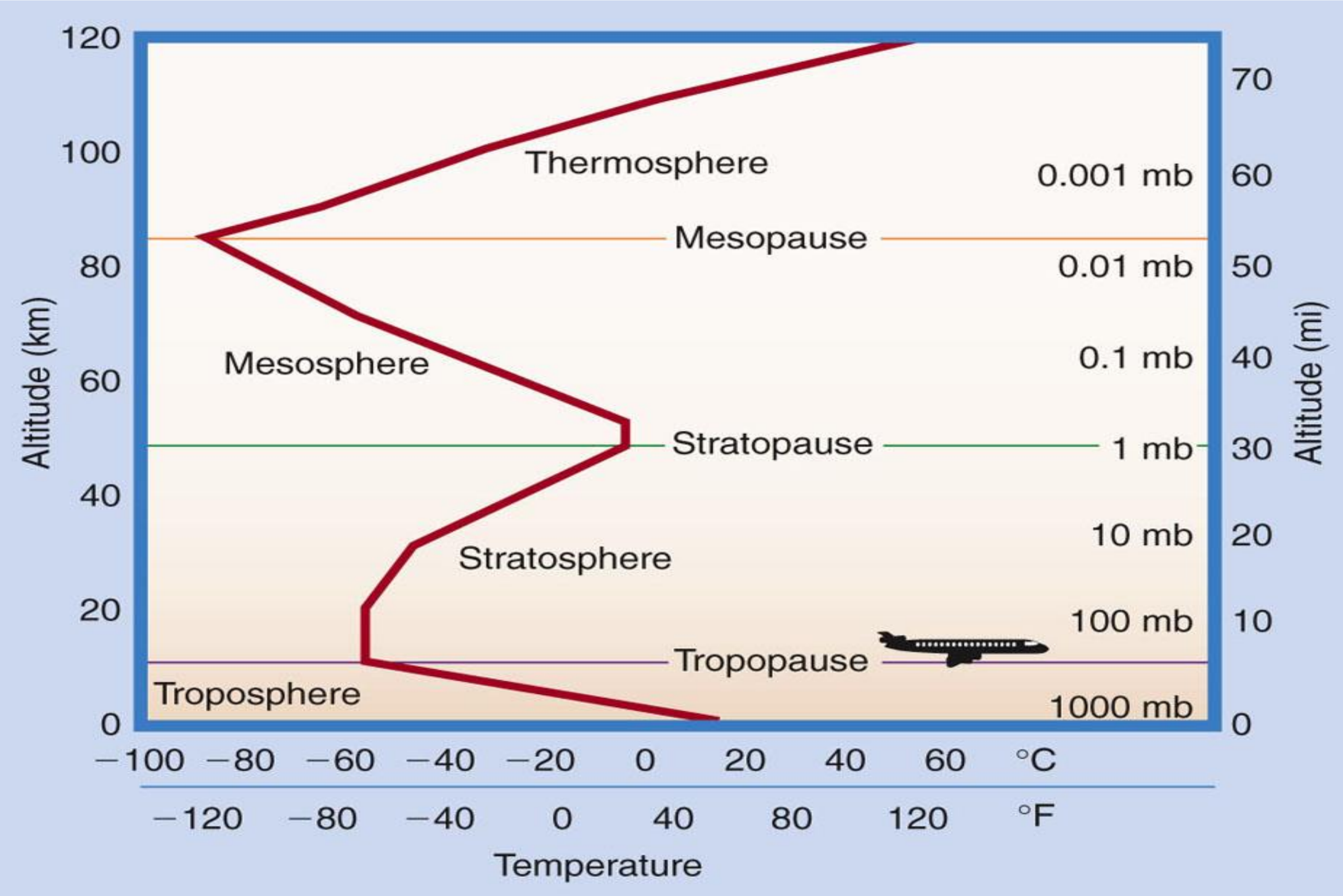
- Troposphere – (sphere of the weather)
  - temperature decreases with height
- Stratosphere – (layered sphere)
  - temperature increases with height
- Mesosphere – (intermediate sphere)
  - temperature decreases with height
- Thermosphere – (hot sphere)
  - temperature increases with height



Above those layers, there is the Exosphere, an extremely tenuous, outermost layer of Earth's atmosphere. The exosphere lies above the ionosphere and extends from the so-called exobase, at a height of about 500 km, to the edge of interplanetary space (~10000 km).

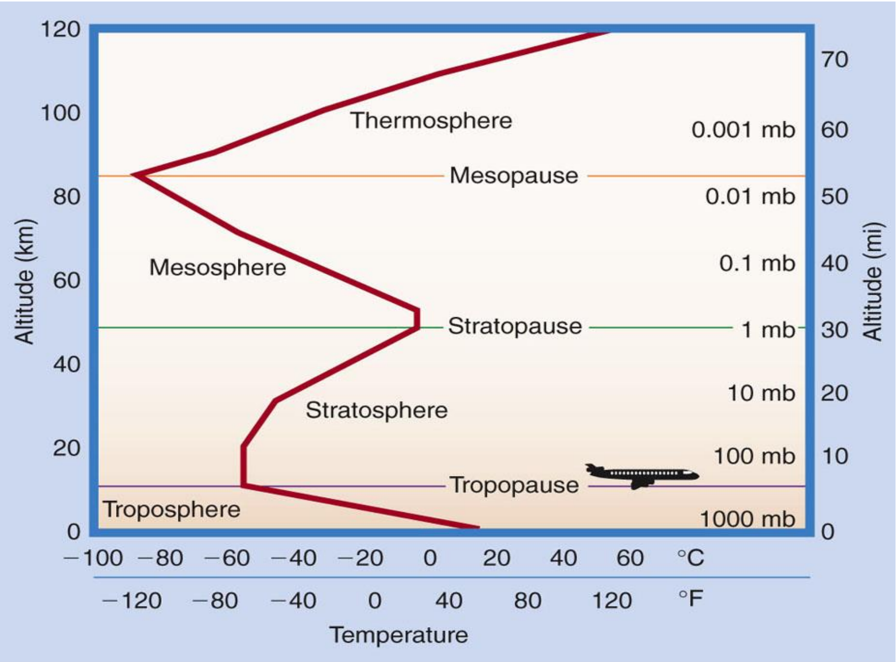
At or below the exobase, the atmosphere is sufficiently dense that collisions dominate the motion of gas molecules and atoms; above the exobase, collisions are so infrequent that atoms moving with sufficient velocity have a high probability of escaping from Earth's gravitational field into interplanetary space.

The main layers of the Earth atmosphere



The troposphere

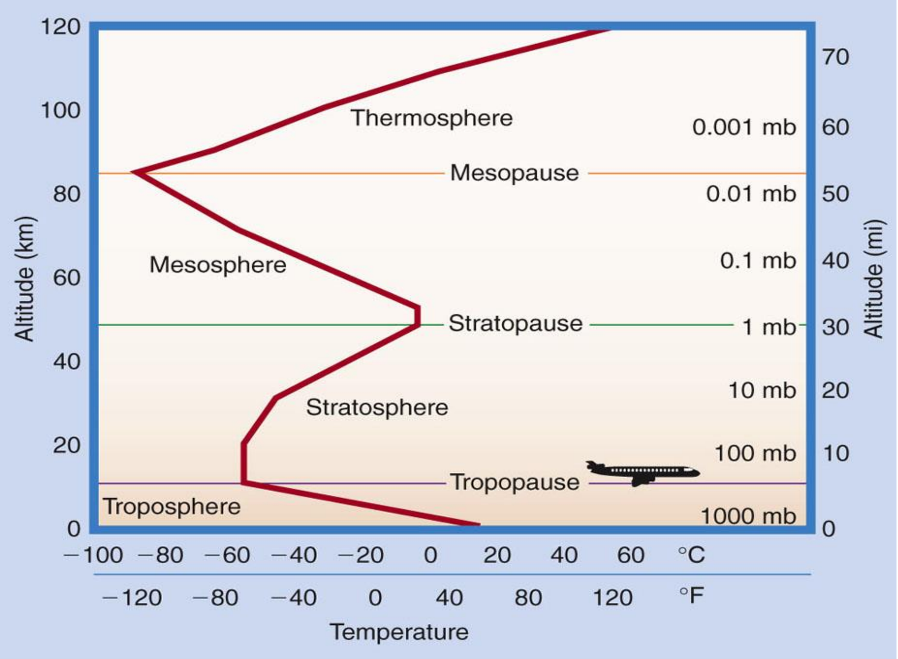
- From the surface up to about 12km (varies with latitude and season – higher in Summer, and in the tropics).
- Literally means region where air "turns over"
- Temperature usually decreases (on average ~6.5°C/km) with altitude because the troposphere is heated by the surface and not directly by sunlight.



- *Almost all of what we call "weather" occurs in the troposphere.*
- Contains 80% of the atmosphere's mass

The stratosphere

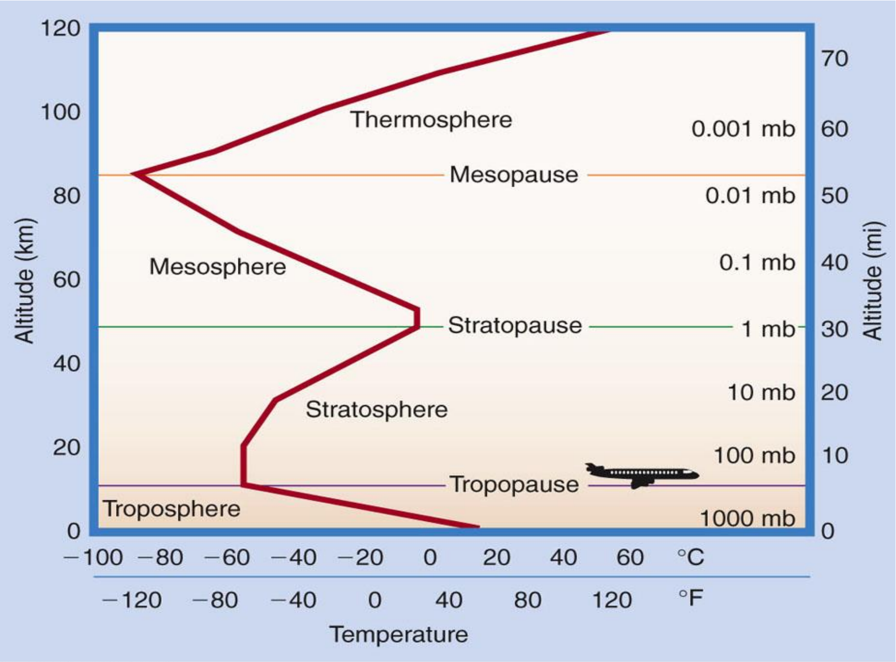
- Between about 12km and 50km.
- Temperature increases with height because the ozone layer absorbs ultraviolet light and warms up as a result.
- Lack of, or little, mixing and turbulence, unlike in the troposphere, where "turbulent mixing" is common



- Very little exchange occurs between the stratosphere and troposphere (but it is important where it does).
- 99.9% of the atmospheric mass below the stratopause.

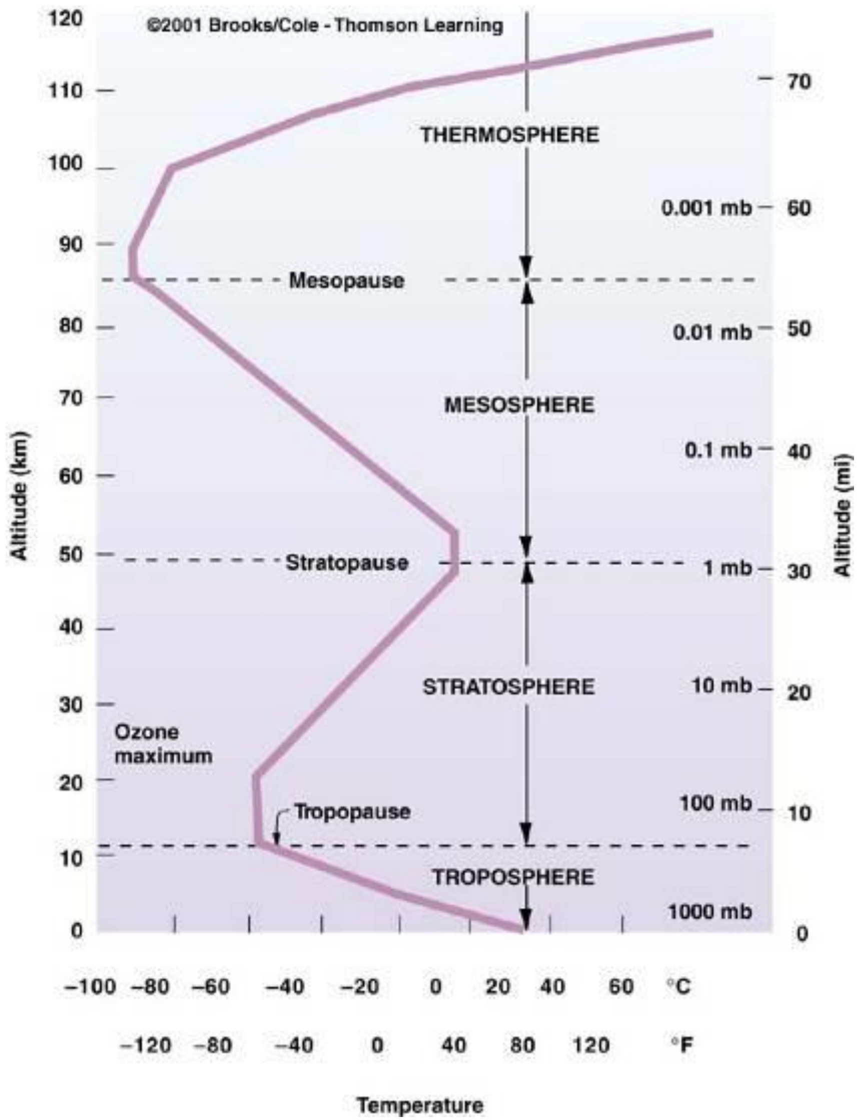
The mesosphere and the thermosphere

- Mesosphere between 50km and 85km: in this region temperature again decreases with height.
- Thermosphere from 120 km to … there is no clear separation between the thermosphere and interplanetary space. This region contains very little of the atmosphere's mass, but receives high energy radiation → high temperatures.



- The highest temperatures in the atmosphere are found in the thermosphere due to high energy radiation being absorbed by gases.
- However, thermosphere has very low density → not much "heat" felt.

Why this distribution of temperature?



- Hot top: oxygen absorbs sunlight
- Warm middle: ozone absorbs ultraviolet (UV)
- Warm surface: land and ocean absorb sunlight

Temperature variations