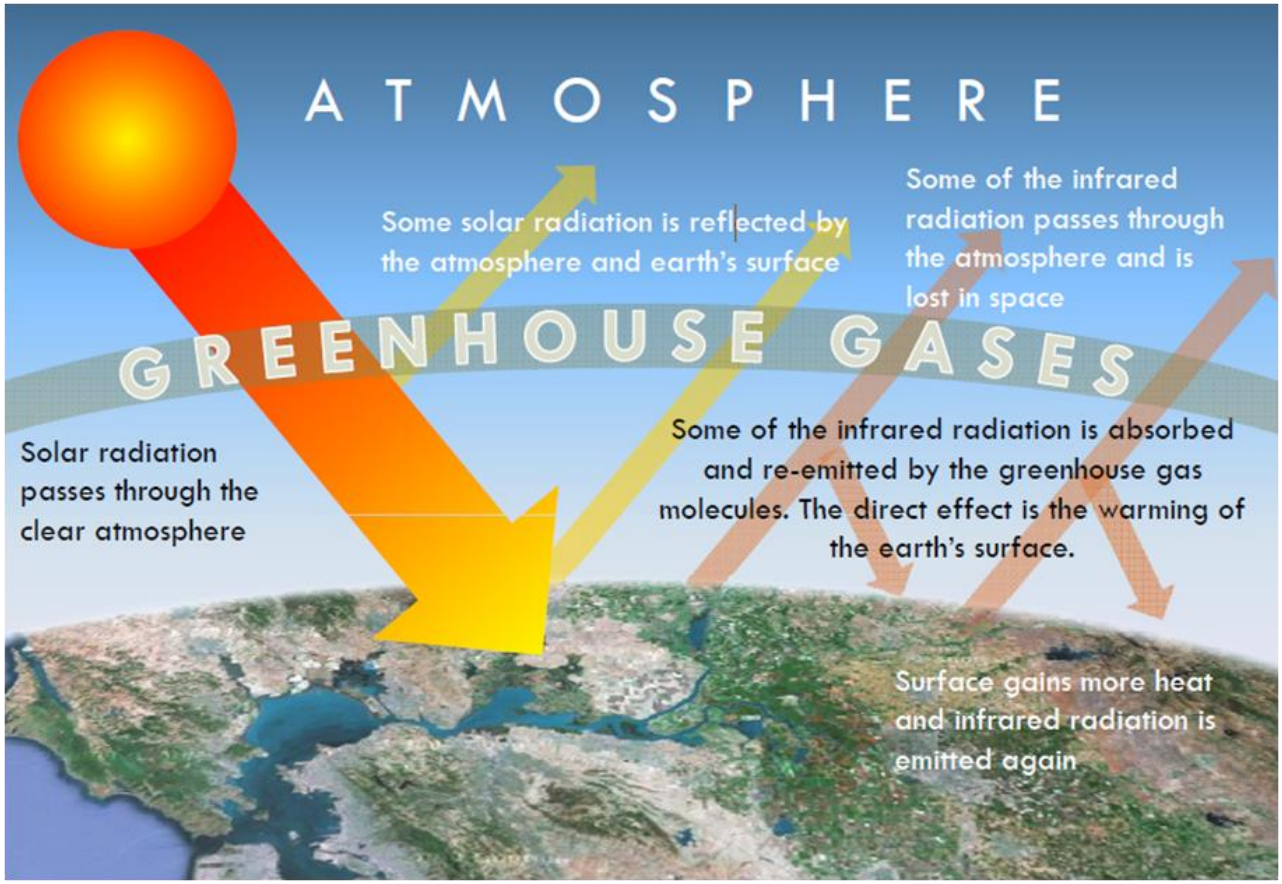
THE ATMOSPHERE

PART 2

What is Greenhouse Effect?

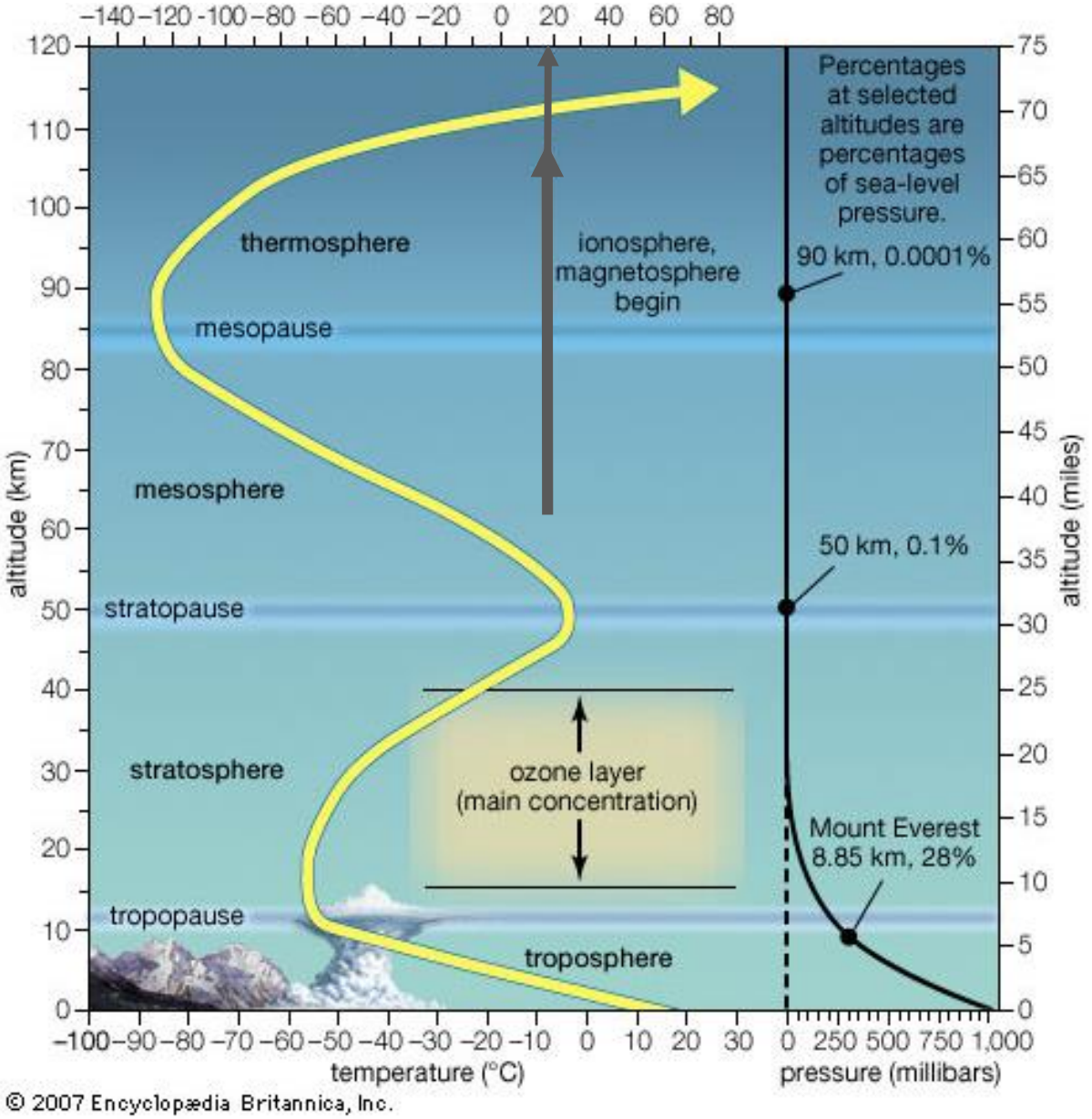
The <u>warming of the atmosphere</u> by absorbing and emitting infrared radiation while allowing shortwave radiation to pass through.

The gases mainly responsible for the Earth's atmospheric greenhouse effect are water vapor and carbon dioxide.

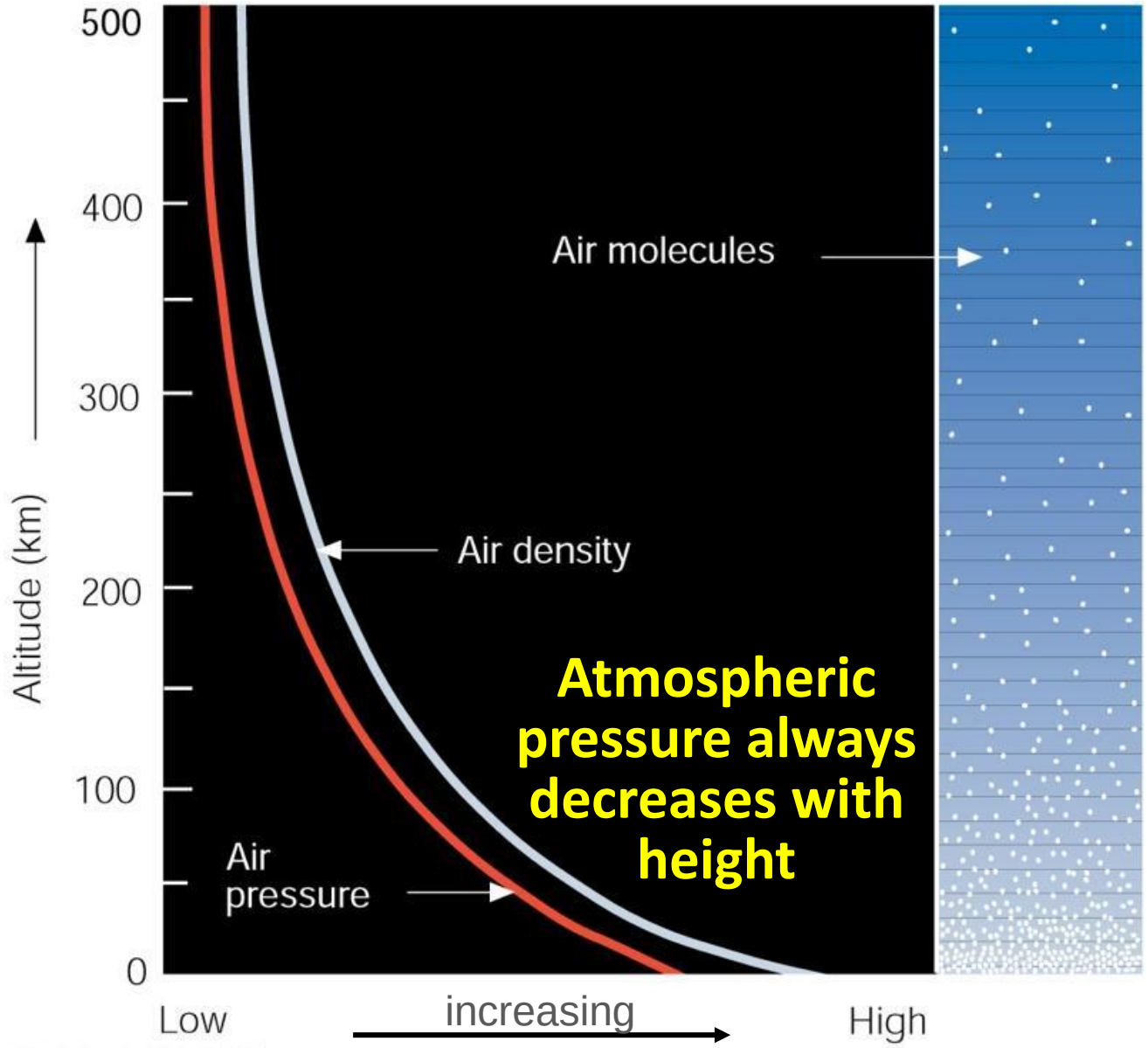


Temperature and Pressure Profile

- Atmospheric **temperature** has a complex profile governed by many factors, including incoming solar radiation, humidity and altitude.
- Atmospheric **pressure** decreases rapidly with height; climbing to an altitude of only 5.5 km the pressure is one-half that at sea level.



Understanding Pressure and Density

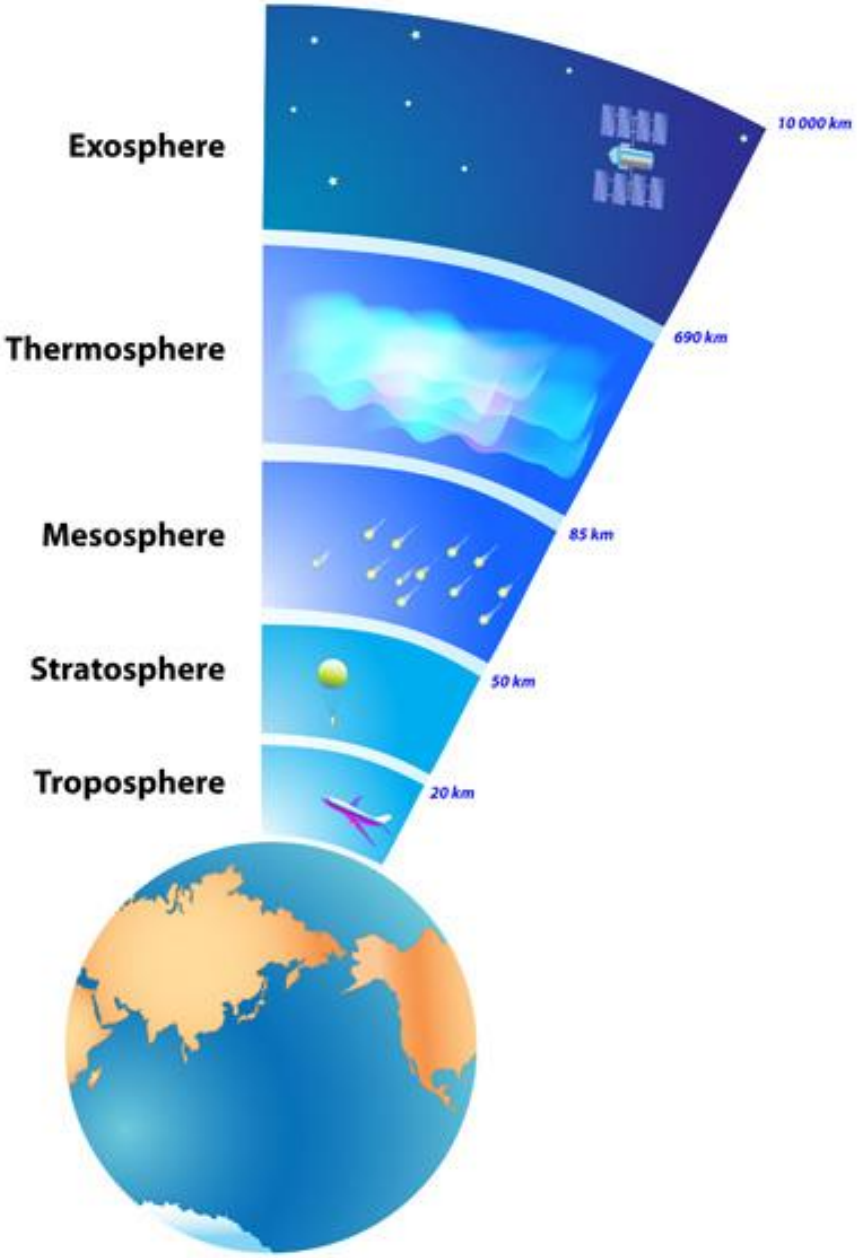


- **Air density is the amount of air (*mass* of air molecules) in a given space (*volume*).**
- **The amount of *force* exerted over an *area* of surface is called pressure.**

Gravity pulls gases toward the Earth's surface!

Layers of the Atmosphere

- **5 main layers** (based on temperature and composition):
  - Troposphere
  - Stratosphere
  - Mesosphere
  - Thermosphere
  - Exosphere



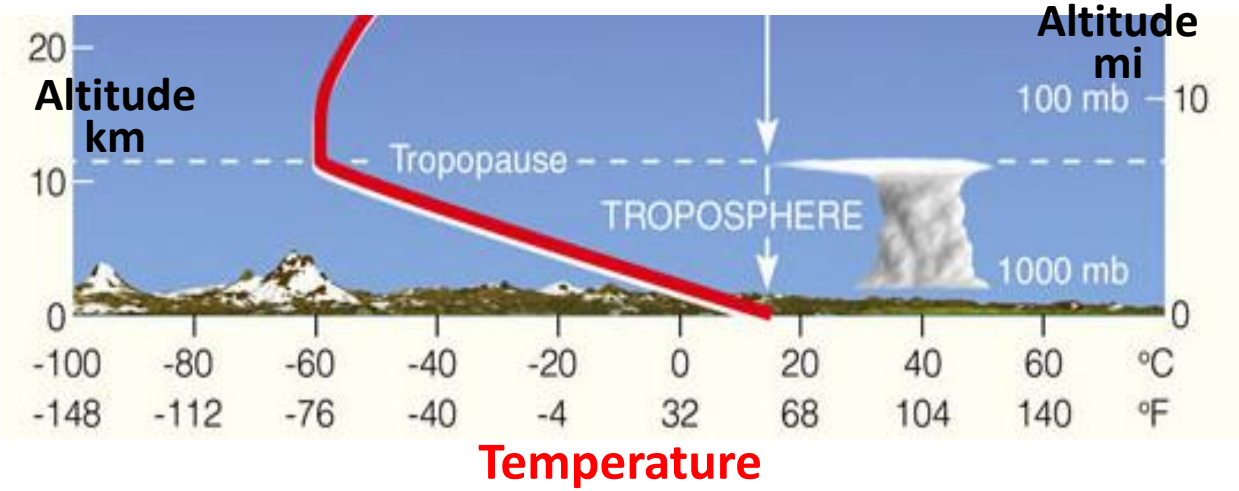
- There is a bottom but no "top" – the atmosphere gradually thins out with increasing altitude.
- Atmospheric effects become noticeable during atmospheric reentry of spacecraft at an altitude of around 120 km (75 mi).

Troposphere

- The lowest region, **0 to ~12 km**

  (9 km at the poles, 17 km at the equator).

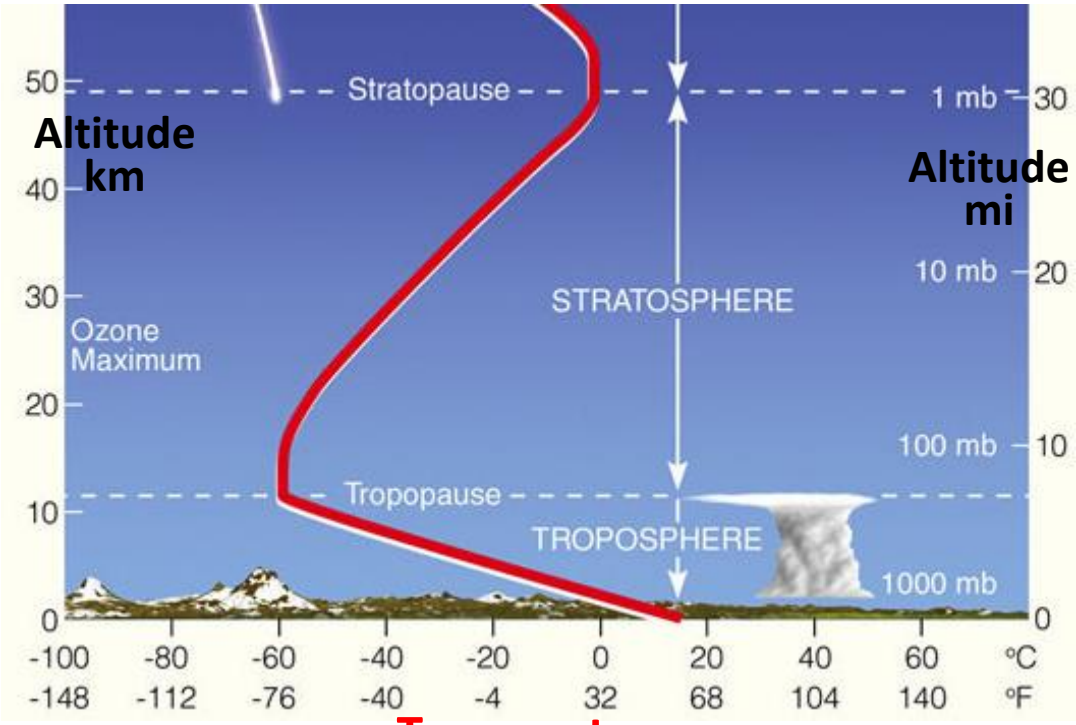
Life exists here!



- Contains roughly 80% of the mass of the Earth's atmosphere.
- Contains nearly all atmospheric water vapor or moisture.
- Temperature decreases with altitude (at ~6.5°C/km): infrared radiation emitted by the Earth is absorbed by the air; as air becomes less dense with increasing altitude, less molecules are there to absorb heat.
- Highly unstable layer (turbulence and mixing): this is where the weather exists.
- Place of most conventional aviation activity.

Stratosphere

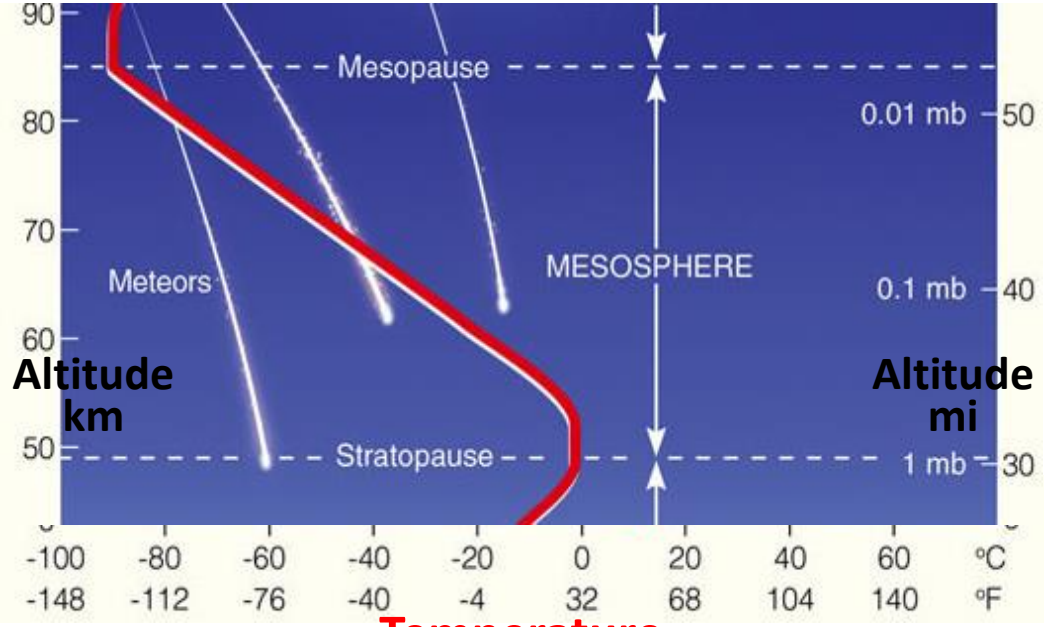
- **~15 to 50 km**
- **Contains the ozone layer (maximum O_3 content at 20-30 km)**
- **Temperature increases with altitude (*inversion layer*): heating due to ozone absorbing UV radiation from the Sun.**



- **Restricted turbulence and mixing, very stable atmospheric conditions.**
- **Almost completely free of clouds and other forms of weather.**
- **The highest layer that can be accessed by jet-powered aircraft.**

Mesosphere

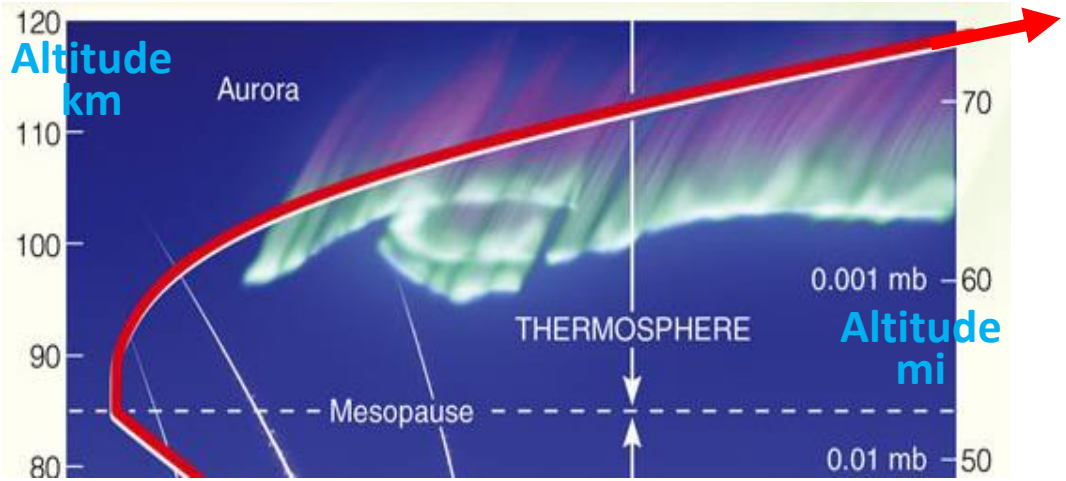
- **50 to ~85 km**
- **Temperature decreases with altitude.**
- **It is the coldest place on Earth:**
  lowest temperatures in the entire atmosphere are found at the top of mesosphere (*mesopause*) during summer at high latitudes, 130 K (-226°F) can occur.



- **Home to polar-mesospheric noctilucent clouds - the highest clouds in the atmosphere.**
- **Most meteors burn up here upon atmospheric entrance.**
- **Too high above Earth to be accessible to aircraft and balloons, and too low to permit orbital spacecraft, the mesosphere is mainly accessed by sounding rockets.**

Thermosphere

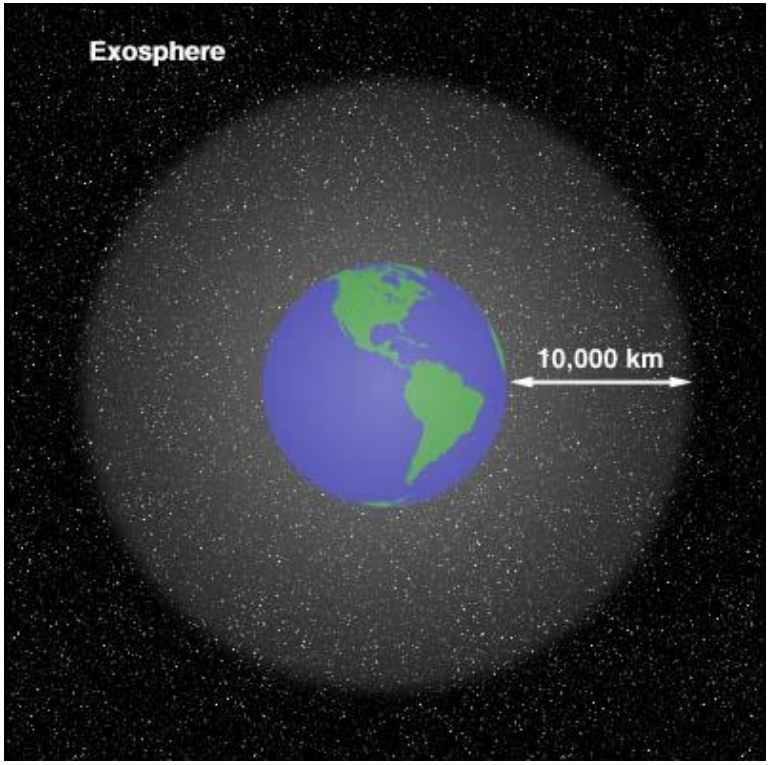
- **90 to 500 km**
- **Temperature increases with altitude due to absorption of solar radiation by molecular oxygen (O_2).**



- **This layer can be as hot as 1500 °C (2700 °F), though the gas molecules are so very far apart that its temperature in the usual sense is not very meaningful…**
- **Extremely low pressure and density: the air is so rarefied that molecules travel an average of 1 km (0.62 mi) between collisions!**
- **Completely cloudless and free of water vapor.**
- **Part of the ionosphere (air is partly *ionized*) – home to auroras.**
- **The International Space Station orbits here, between 320 and 380 km (200 and 240 mi).**

Exosphere (Geocorona)

- The outermost layer (many scientists do not consider the exosphere a part of the Earth's atmosphere at all!)
- ~500-700 km depending on solar activity, to ~10,000 km (arbitrary boundary).
- Technically there is no top – the exosphere merges with the emptiness of outer space.
- Mainly composed of extremely low densities of hydrogen, helium and several heavier molecules.



- The atoms and molecules are so far apart that they can travel hundreds of kilometers without colliding with one another: the exosphere no longer behaves like a gas, and the particles constantly escape into space.
- Contains most of the satellites orbiting Earth.