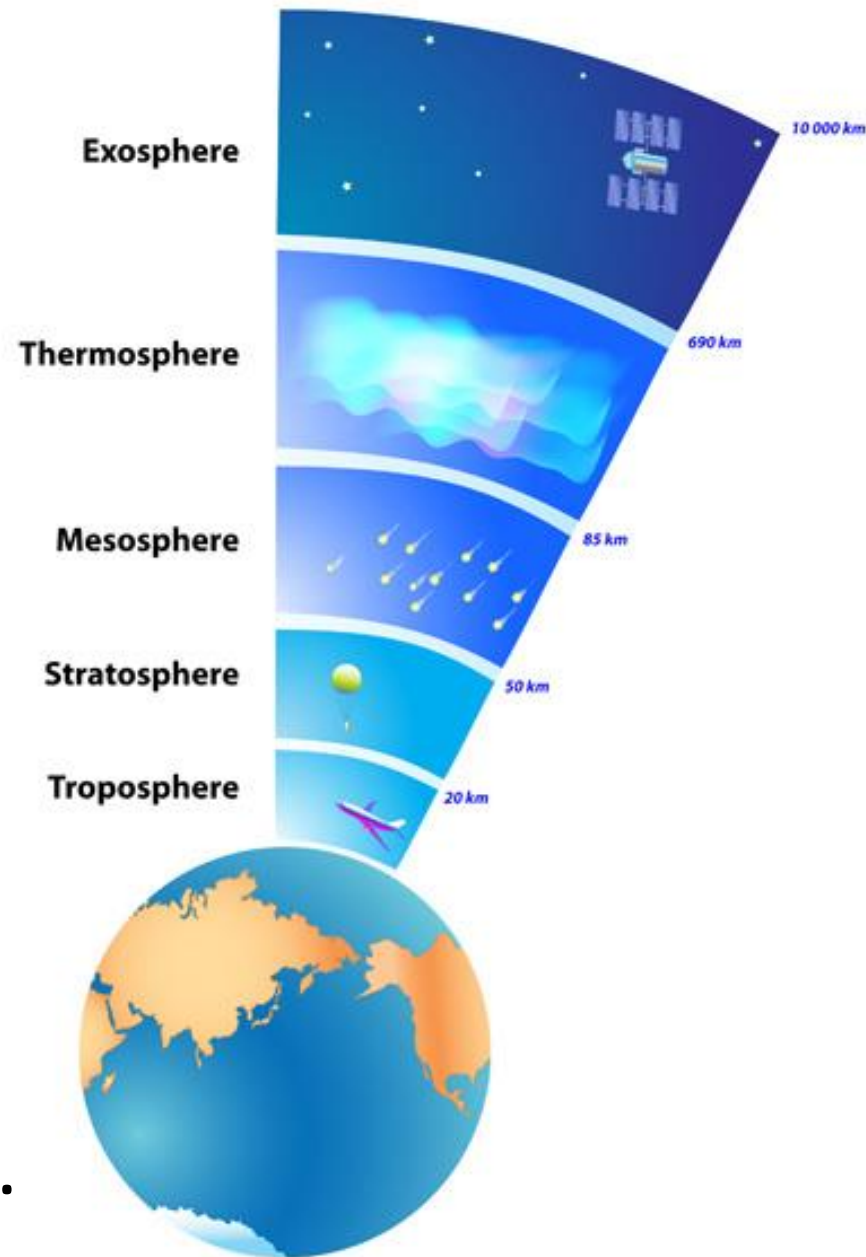


# Layers of the Atmosphere

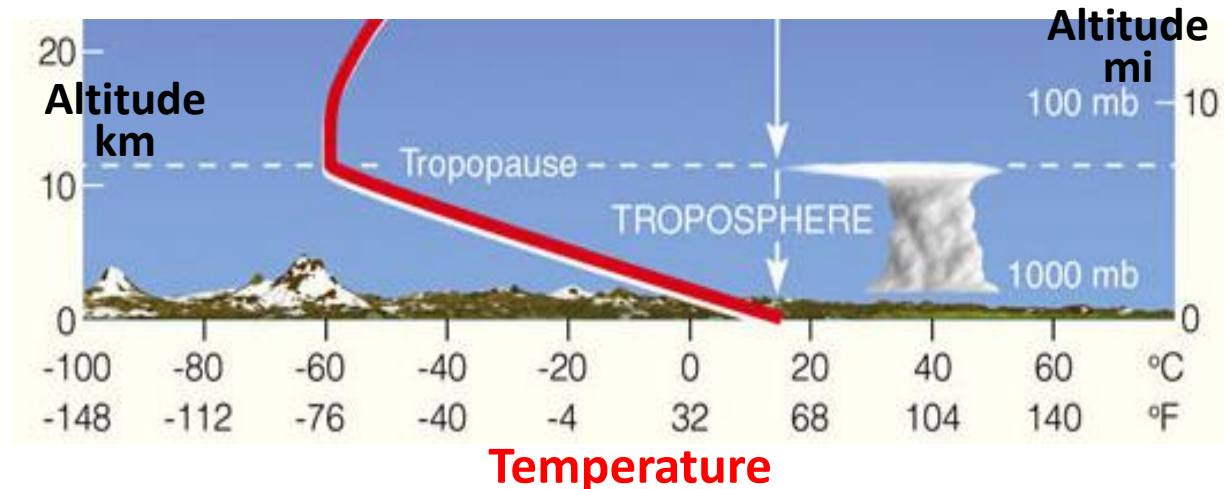
- 5 main layers (based on **temperature** and **composition**):
  - Troposphere
  - Stratosphere
  - Mesosphere
  - Thermosphere
  - Exosphere
- There is a bottom but **no “top”** — the atmosphere gradually thins out with increasing altitude.
- Atmospheric effects become noticeable during atmospheric 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).

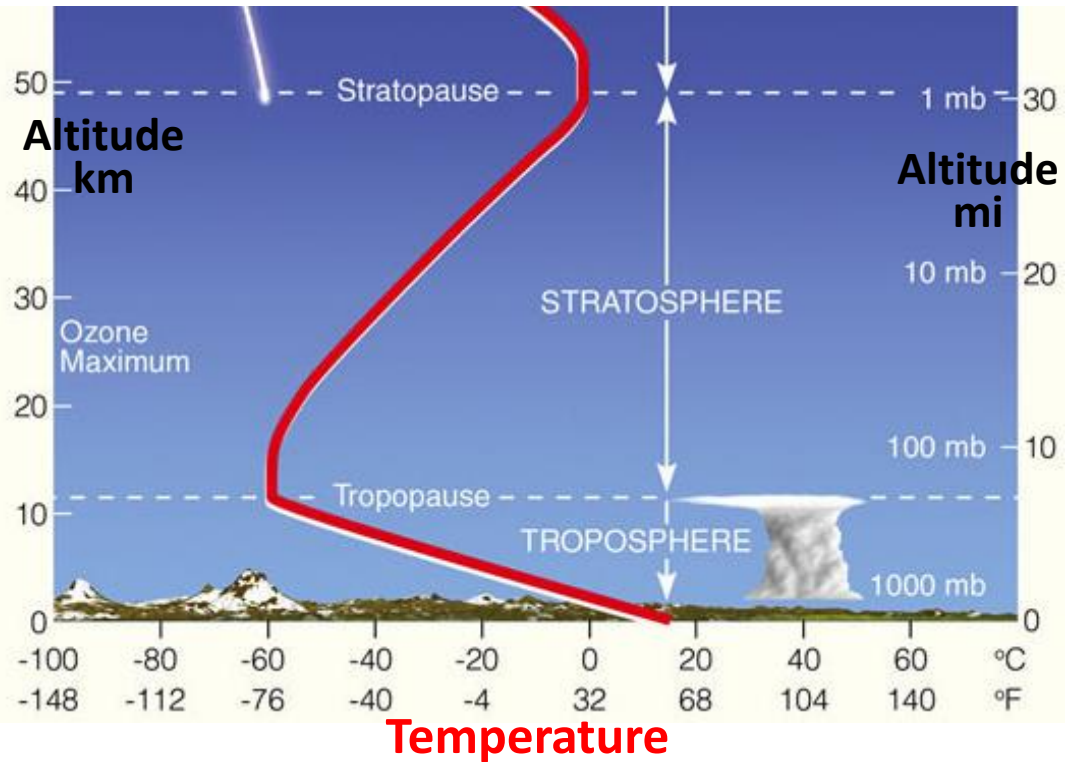
Life exists here!



- Contains roughly 80% of the mass of the Earth's atmosphere.
- Contains **nearly all atmospheric water vapor or moisture**.
- **Temperature decreases with altitude** (at  $\sim 6.5^{\circ}\text{C}/\text{km}$ ): 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

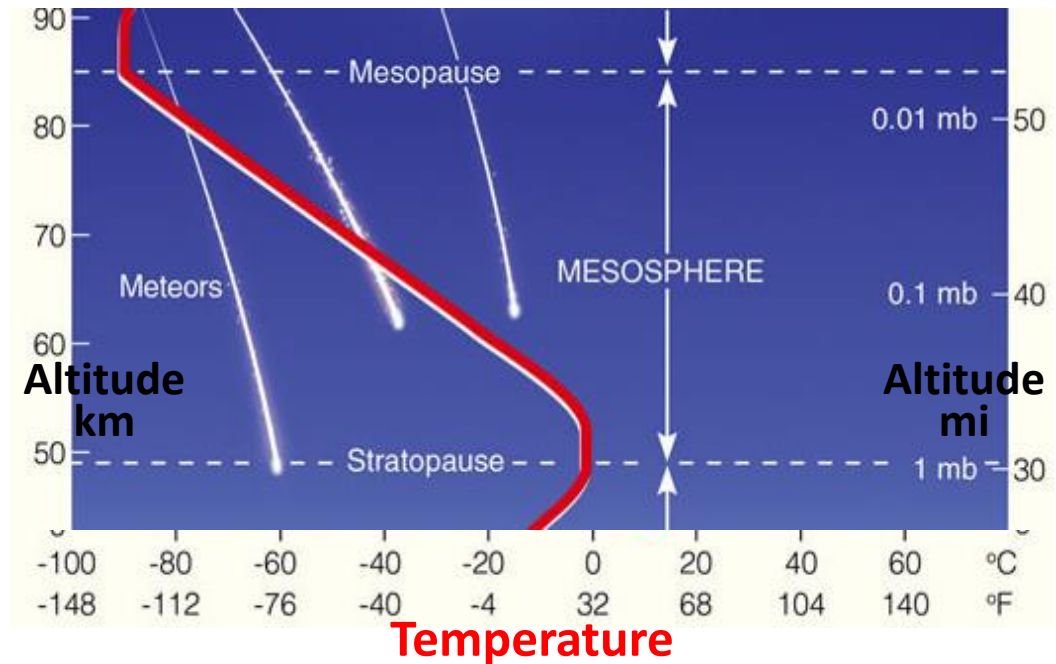
- ~15 to 50 km
- Contains the **ozone layer** (maximum O<sub>3</sub> content at 20-30 km)
- **Temperature increases with altitude (inversion layer):** heating due to ozone absorbing UV radiation from the Sun.



- 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

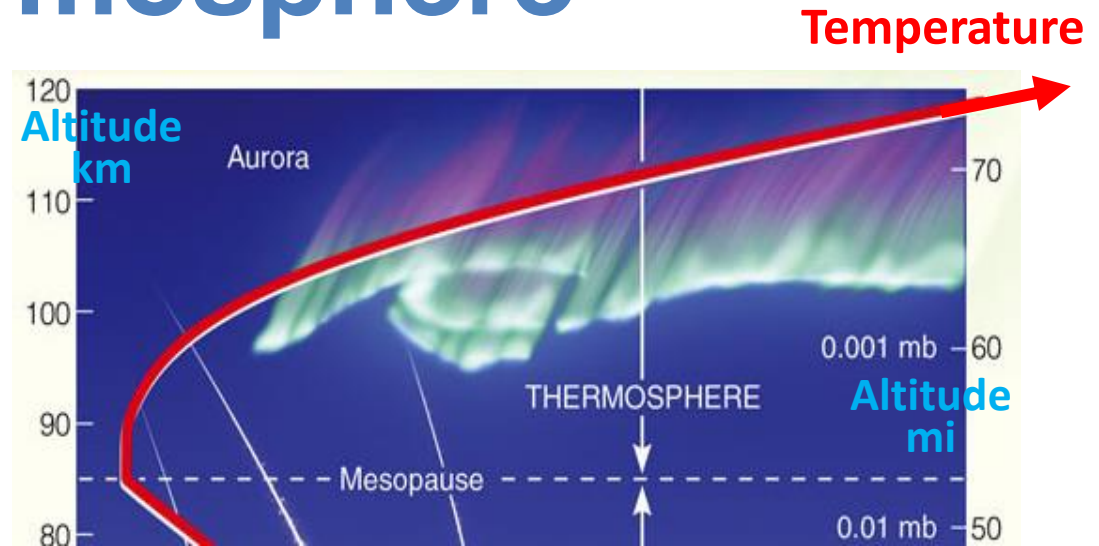
- 50 to ~85 km
- **Temperature decreases with altitude.**
- It is **the coldest place on Earth**: lowest temperatures in the entire atmosphere are found at the top of mesosphere (*mesopause*) during summer at high latitudes, 130 K (-226°F) can occur.



- 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<sub>2</sub>).



- 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.

