

# THE ATMOSPHERE



# Atmosphere

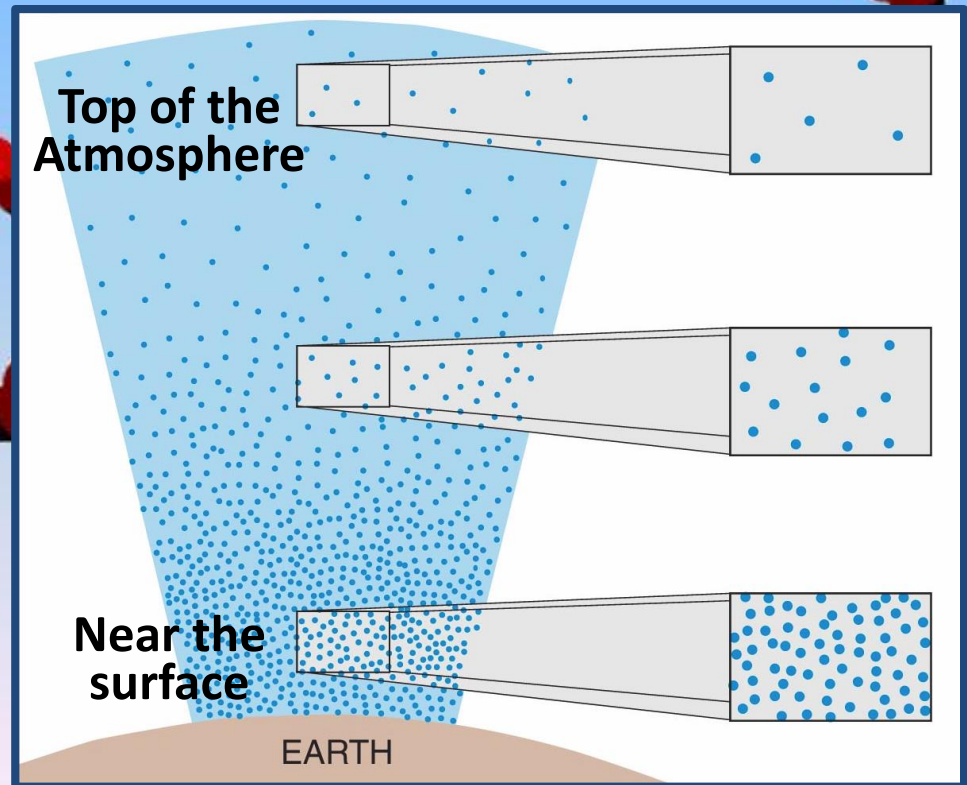
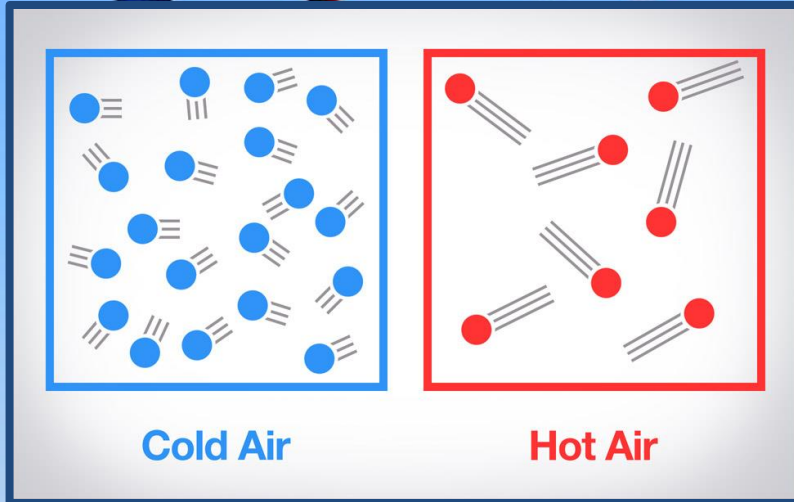
from Greek ἀτμός [*atmos*] "**vapor**" and σφαῖρα [*sphaira*] "**sphere**"

- An atmosphere is a layer of gases surrounding a material body of sufficient mass that is held in place by the gravity of the body.
- The **Earth's atmosphere protects life on Earth** by absorbing ultraviolet solar radiation, warming the surface through heat retention (*greenhouse effect*), and reducing temperature extremes between day and night.



- The atmosphere is a **gas**.
- The atmosphere is a **fluid**.
- The atmosphere has a **mass of about  $5.15 \times 10^{18}$  kg**.

The air is made up of *molecules*: particles that are in constant motion.



# Evolution of the Atmosphere

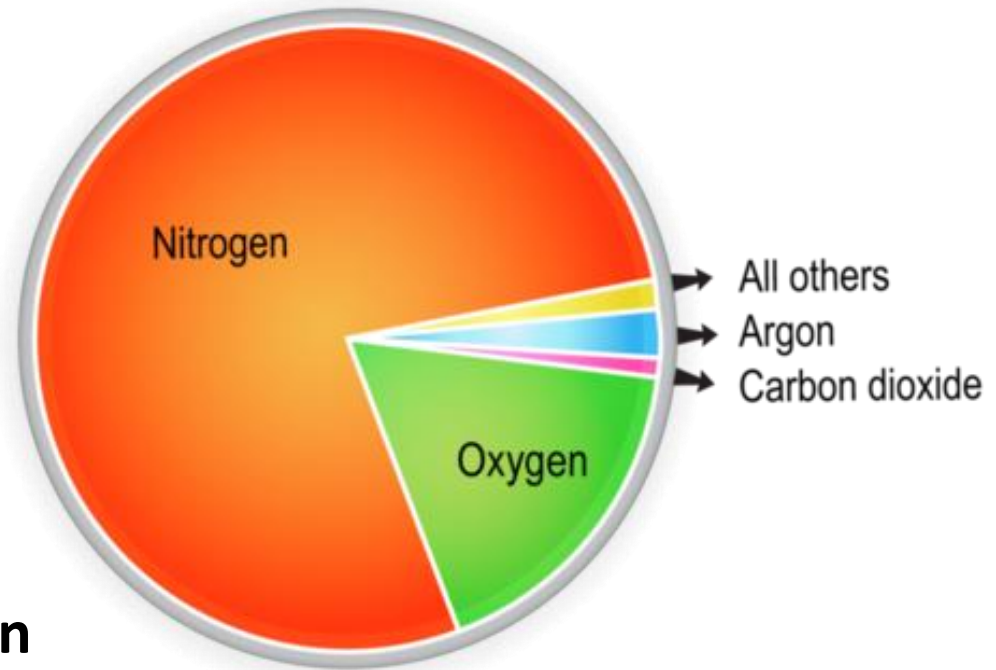
- **Reduced primitive atmosphere**  
(*stellar gas* composition: H, He, CH<sub>4</sub>, NH<sub>3</sub>)
- **Outgassing and the second atmosphere**  
(mostly N<sub>2</sub>, Ar, CO<sub>2</sub> – still no oxygen!)

The **evolution of life** and atmosphere are closely linked – life produces oxygen (photosynthesis) and cycles carbon (*e.g.* limestone).

- **Oxidized modern atmosphere**  
(mostly N<sub>2</sub>, O<sub>2</sub>, and *very little* CO<sub>2</sub>...)

# Atmospheric Gases

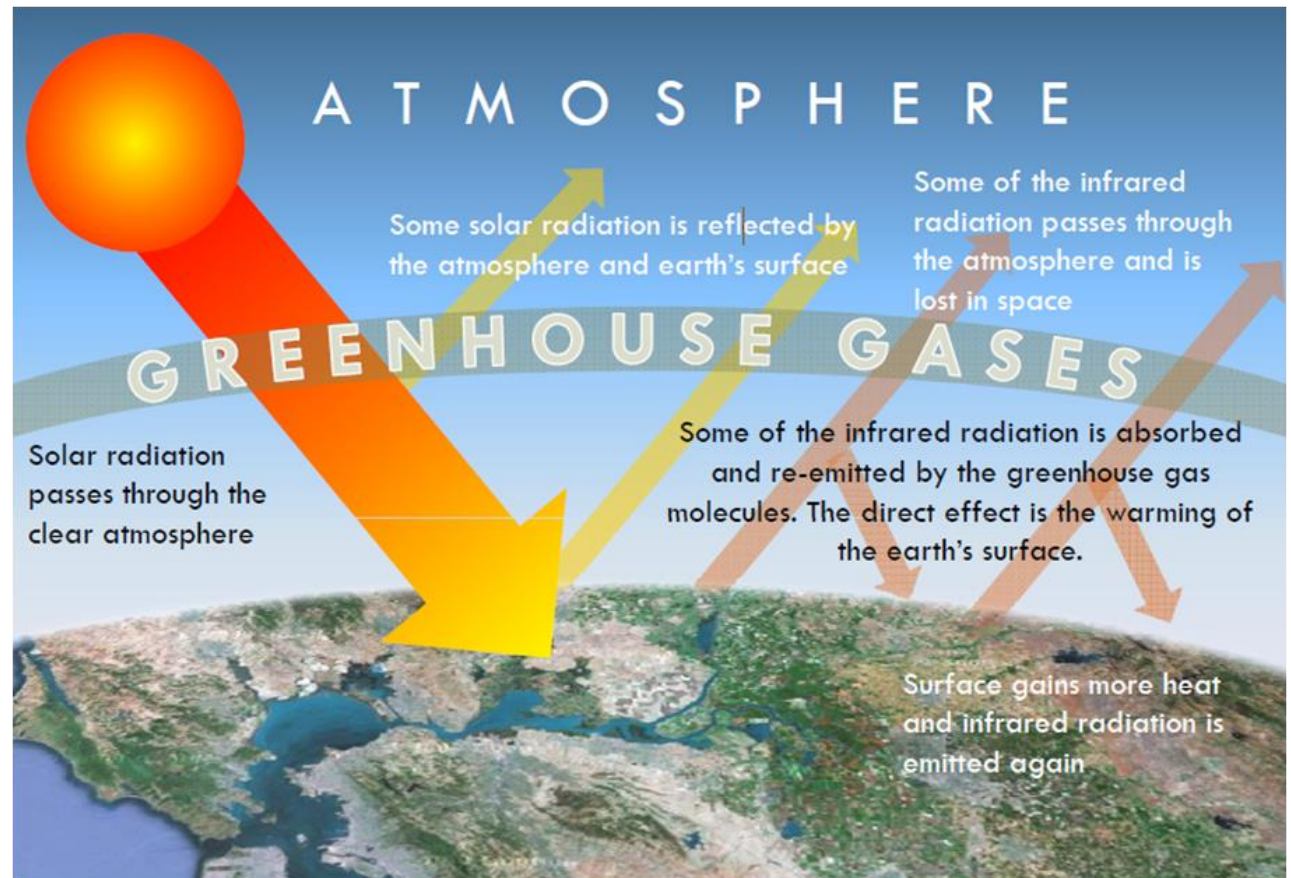
- **Nitrogen** - 78%
- **Oxygen** - 21%
- **Argon** - .93%
- **Water vapor** – 0 to 4%
  - clouds and precipitation
- **Traces** of neon, helium, methane, krypton, xenon, hydrogen, ozone, and...
- ...carbon dioxide - .04% (year 2015)
  - keeps Earth warm and is used by plants to make food



# What is Greenhouse Effect?

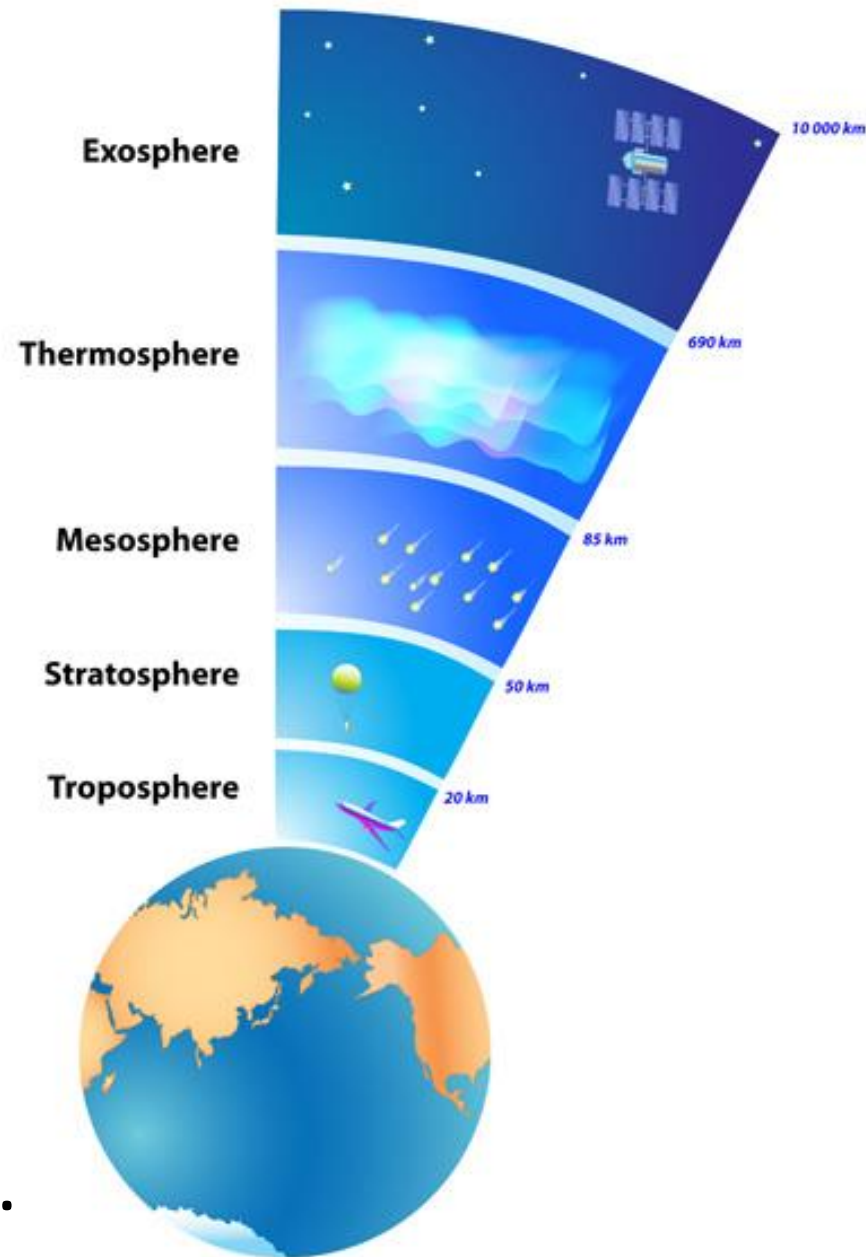
The warming of the atmosphere by absorbing and emitting infrared radiation while allowing shortwave radiation to pass through.

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



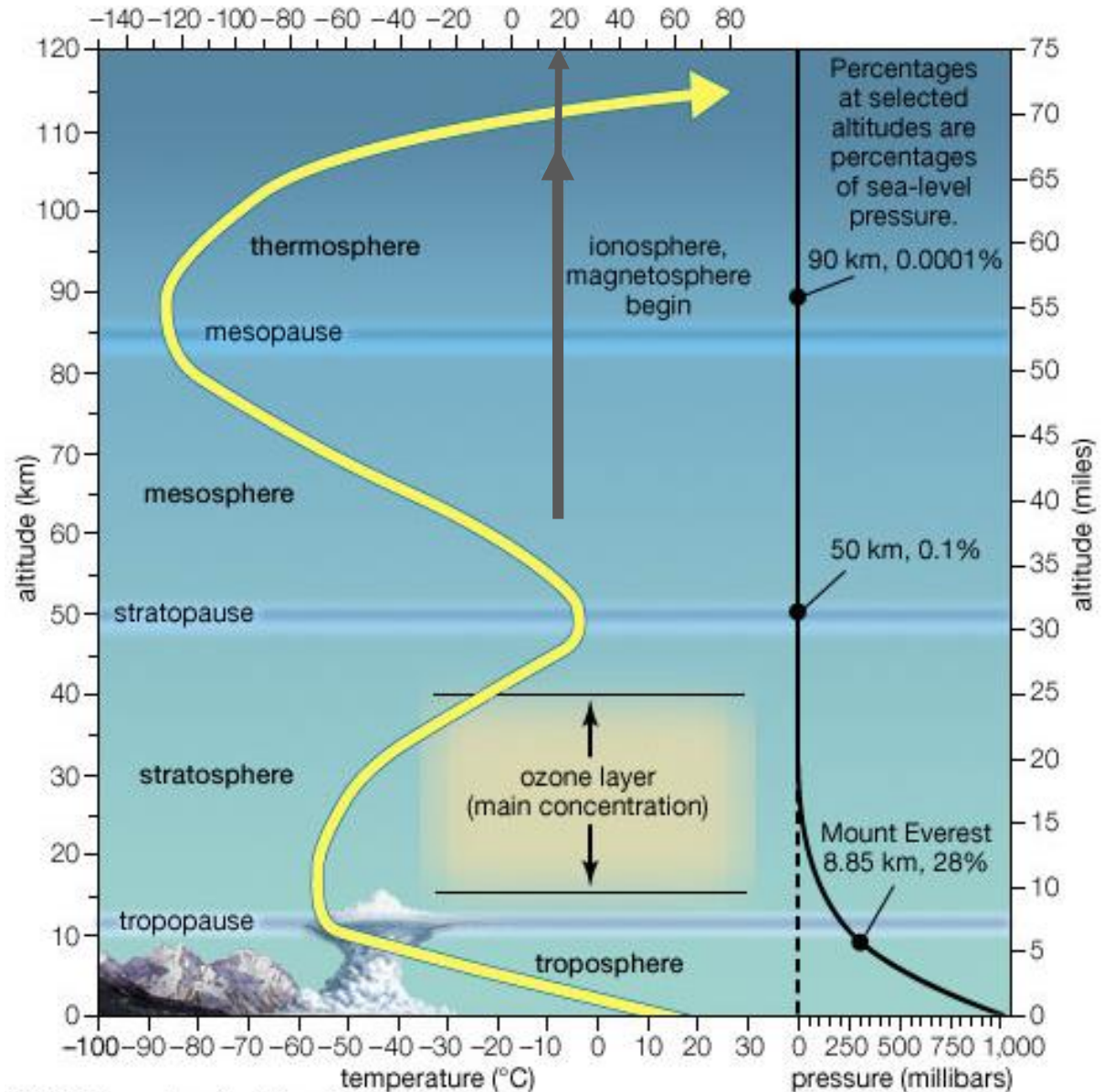
# Layers of the Atmosphere

- 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).



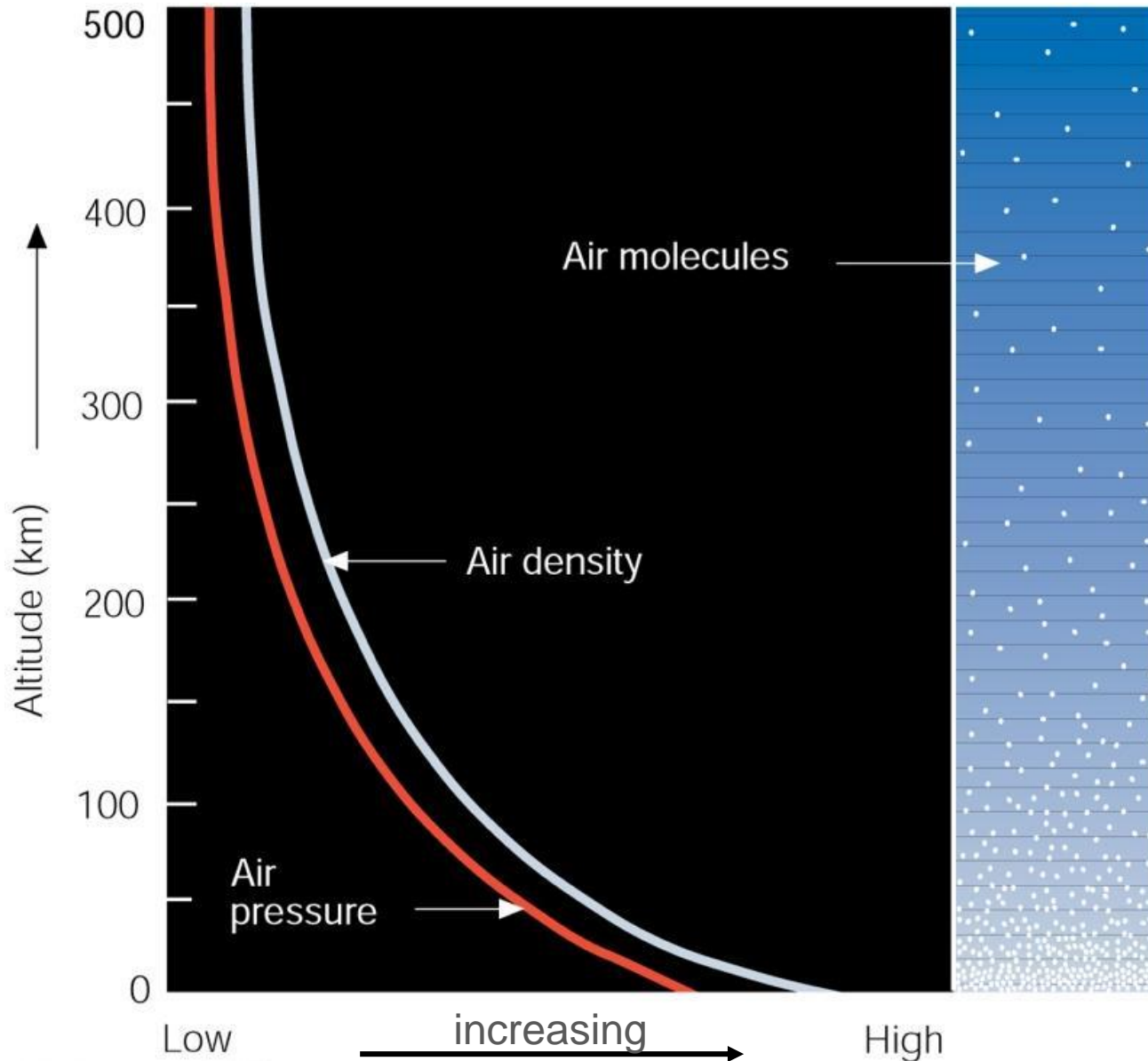
# Temperature and Pressure Profile

- 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!