The Earth's Atmosphere

The Earth and its Atmosphere

This chapter discusses:

1. **Gases in Earth's atmosphere**
2. **Vertical structure of atmospheric pressure & temperature**
3. **Types of weather & climate in the atmosphere**

Solar Energy as Radiation

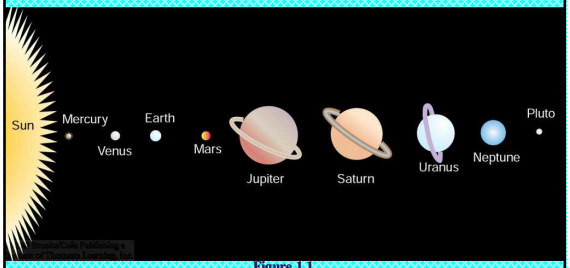


Figure 1.1

Nearly 150 million kilometers separate the sun and earth, yet solar radiation drives earth's weather.

Earth's Atmosphere

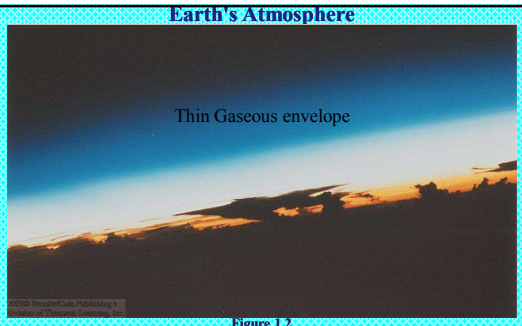


Figure 1.2

99% of atmospheric gases, including water vapor, extend only 30 kilometer (km) above earth's surface.

Most of our weather, however, occurs within the first 10 to 15 km.

Composition of Atmosphere

- **Nitrogen - 78%**
- **Oxygen - 21%**
- **Water Vapor – 0 to 4%**
- **Carbon Dioxide - .037%**
- **Other gases make up the rest**

Atmospheric Gases

Nitrogen, oxygen, argon, water vapor, carbon dioxide, and most other gases are invisible.

Clouds are not gas, but condensed vapor in the form of liquid droplets.

Ozone – is the primary ingredient of smog!

Ground based smog, which is visible, contains reactants of nitrogen and ozone.

Variable & Increasing Gases

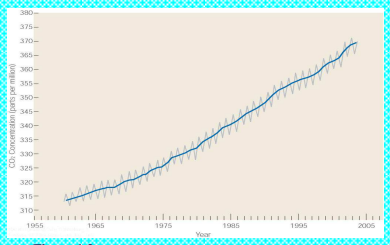


Figure 1.3

Nitrogen and oxygen concentrations experience little change, but carbon dioxide, methane, nitrous oxides, and chlorofluorocarbons are greenhouse gases experiencing discernable increases in concentration. CO2 has risen more than 18% since 1958. Fossil fuels are the biggest problem!

Atmospheric Greenhouse Effect

- The warming of the atmosphere by its 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.

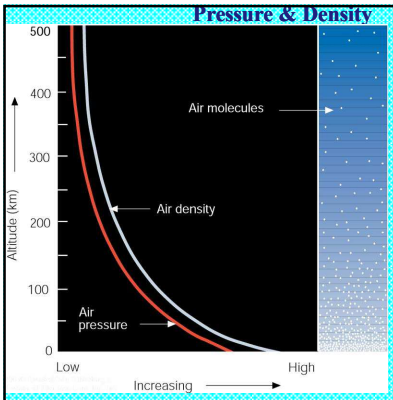
Aerosols & Pollutants

Human and natural activities displace tiny soil, salt, and ash particles as suspended aerosols,

as well as sulfur and nitrogen oxides, and hydrocarbons as pollutants.

Figure 1.6

Pressure & Density



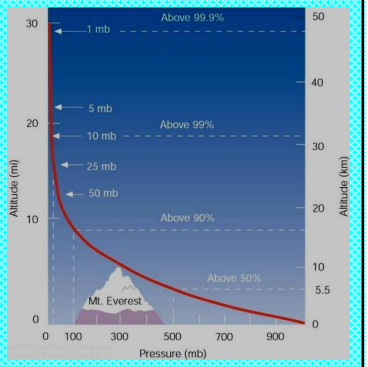
Gravity pulls gases toward earth's surface, and the whole column of gases weighs 14.7 psi at sea level, a pressure of 1013.25 mb or 29.92 in.Hg.

The amount of force exerted Over an area of surface is called Air pressure!

Air Density is The number of air Molecules in a given Space (volume)

Vertical Pressure Profile

Atmospheric pressure decreases rapidly with height. Climbing to an altitude of only 5.5 km where the pressure is 500 mb, would put you above one-half of the atmosphere's molecules.



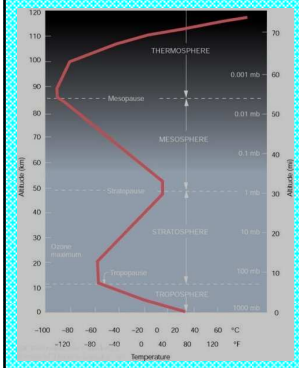
Lapse Rate

- The rate at which air temperature decreases with height.
- The standard (average) lapse rate in the lower atmosphere is about 6.5°C per 1 km or 3.6°F per 1000 ft.

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)

Atmospheric Layers



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

Atmospheric Layers

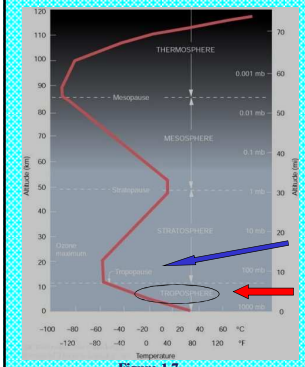
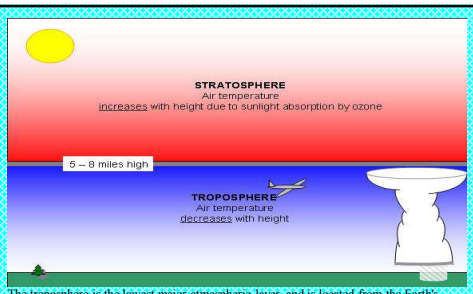


Figure 1.7

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

Troposphere – Temp decrease w/ height
Most of our weather occurs in this layer
Varies in height around the globe, but Averages about 11 km in height.



The troposphere is the lowest major atmospheric layer, and is located from the Earth's surface up to the bottom of the stratosphere. It has decreasing temperature with height (at an average rate of 3.5° F per thousand feet (6.5 ° C per kilometer); whereas the stratosphere has either constant or slowly increasing temperature with height. The troposphere is where all of Earth's weather occurs. The boundary that divides the troposphere from the stratosphere is called the "tropopause", located at an altitude of around 5 miles in the winter, to around 8 miles high in the summer, and as high as 11 or 12 miles in the deep tropics. When you see the top of a thunderstorm flatten out into an anvil cloud, like in the illustration above, it is usually because the updrafts in the storm are "bumping up against" the bottom of the stratosphere.

Atmospheric Layers

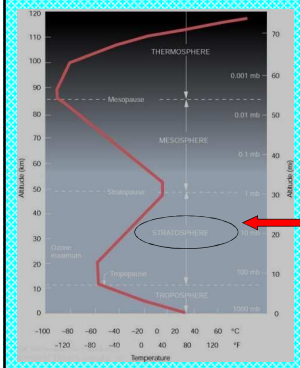


Figure 1.7

Stratosphere
Temperature inversion in stratosphere
Ozone plays a major part in heating the air
At this altitude

Atmospheric Layers

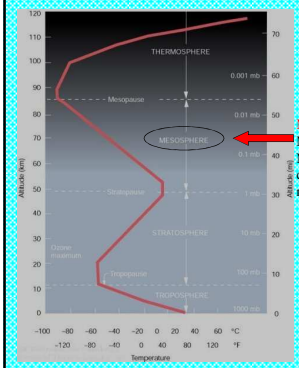


Figure 1.7

Mesosphere
Middle atmosphere – Air thin, pressure low. Need oxygen to live in this region. Air quite Cold -90°C (-130°F) near the top of mesosphere

Atmospheric Layers

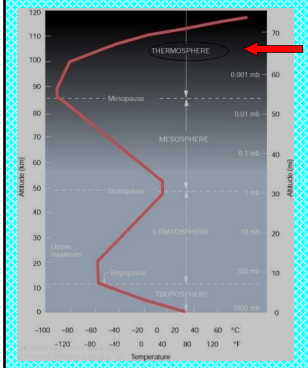


Figure 1.7

Thermosphere
"Hot layer" – oxygen molecules absorb energy from solar Rays warming the air. Very few atoms and molecules in this Region.