Structure of the Atmosphere

Troposphere

- Average height is 10-11 km (7 mi); 15-16 km at the equator; 5-6 km at the poles
- 75-80% of total mass
- Temperature generally decreases with height; Average lapse rate is 6.5°/km
- Referred to as the "weather layer"

Stratosphere

- From 11 to 45-50 km
- Temperature is constant with height initially, then it increases with Z, known as an inversion (temperature increases w/z)
- ~20-25% of total mass
- Lid to the troposphere and important to aircraft

Mesosphere (from the Greek *meso* meaning middle)

- From 45 to 92 km
- Less than 1% of the total mass
- Sharp decline in temperature -93°C (-137°F) at top

Thermosphere (from the Greek *therme* meaning heat)

- Increase in temperatures (extremely high) due to absorption of radiation
- Very few molecules resulting in very low pressure
- Topped by **exosphere**
- Aurora Borealis and Aurora Australis

Other Layers To Classify The Atmosphere

Ionosphere

- High in the thermosphere
- X-rays and ultraviolet rays ionize gases
- Radio waves depleted during the day

Ozonosphere

- From the bottom of the stratosphere to the just above it
- Ozone absorbs ultraviolet radiation

Homosphere (*homo* means same)

- Well-mixed gases from 0-80 km

Heterosphere (*hetero* means different)

- Settling of gases according to weight above 80 km

Chemical Constituents of the Atmosphere

1. Nitrogen (N_2) - 78% (by volume)
2. Oxygen (O_2) - 21%
3. Argon (Ar) - 1%
4. Carbon Dioxide (CO_2) - 0.038% (376 ppm) and rising

Trace Elements (in varying amounts)

- H_2O (up to 4%)
- Sulfur Dioxide (SO_2)
- Nitrogen Dioxide (NO_2)
- Carbon Monoxide (CO)
- Ozone (O_3)
- Chlorofluorocarbons (CFC's)
- Methane (CH_4)
- Dust and other particulates
- Liquid water

Importance of Gases

Nitrogen

For all practical purposes it is inactive and cannot be used directly. However, the "Nitrogen Cycle" reveals that it can be broken down into usable compounds. Atmospheric nitrogen is converted into nitrogen compounds (nitrites and nitrates) by bacteria on plant roots (legumes such as clover, soy bean and alfalfa) and by lightning from t-storms. It is then converted into protein (a usable form) where it is ingested by man and animals. Denitrification occurs when nitrogen is returned to the atmosphere by wastes and decomposition.

Oxygen

Discovered by Joseph Priestly in the late 1700's. Allows for breathing (respiration) and fire (combustion).

Argon

Inert. It is a noble gas.

CO_2

Used in photosynthesis. It is a major pollutant resulting from the combustion of fossil fuels. Also known as a greenhouse gas because it absorbs infrared (IR) radiation.

Ozone

Contained in the stratosphere (or the aptly-named ozonosphere,) ozone absorbs ultraviolet radiation. Near the surface, ozone is a pollutant causing eye irritations, respiratory problems and dizziness. Ozone smells pungent and is the result of interactions of sunlight and car exhaust.

Chlorofluorocarbons (CFC's)

Act as catalysts to break down ozone. They are important in the stratosphere.

Methane – CH_4

Methane is another significant greenhouse gas. Methane is produced by decomposition and the expulsion of digestive gases.

Water

Water vapor is invisible. It is the most significant Greenhouse gas.

Dust

Aerosols are airborne solids that can reflect incoming and outgoing radiation. Major sources include sea salt from evaporated sea spray, wind-blown dust and debris from volcanoes and fires, and from anthropogenic (man-made) sources. Particulates can remain suspended in the stratosphere for long periods of time and influence global weather, *e.g.* Krakatoa in 1883. Particulates can also act as cloud condensation nuclei (**CCN**) onto which water vapor condenses.

What Is Meteorology The Study Of Anyway?

A meteor is a phenomenon (other than a cloud) observed in the atmosphere consisting of precipitation, a suspension of liquid or frozen water, or other particulate matter, or an optical or electrical manifestation. From the Greek *meteoros* meaning lofty.

- Hydrometeor - water and precipitation, *i.e.* rain, snow, sleet, mist, fog, sea spray, hail, *etc.*

- Lithometeor - solid, dry particle, *i.e.* dust, smoke, ash, *etc.*

- Photometeor - light, *i.e.* halos, rainbows, sun dogs (parhelia), *etc.*

- Electrometeor - atmospheric electricity, *i.e.* lightning, auroras (Aurora Borealis (Northern Lights) or Aurora Australis (Southern Lights)).

Greenhouse Effect

The Greenhouse Effect is a fact that states that the average global temperature (15°C or 59°F) is warmer than it would be given the earth's proximity to the sun because gases in the atmosphere absorb and re-radiate infrared radiation. **Global warming** posits the question "Will an increase in the concentration of greenhouse gases lead to an increased global average temperature?" As of 2009, "global warming" as an issue is being referred to more commonly as "global climate change." An important consideration is the extent to which anthropogenic causes affect the climate versus more natural climate processes and cycles.

Unit One Miscellany

- **Pressure** is the force per unit area of the air.
- Meteorologists measure the air pressure in **millibars** or mb
- Mean Standard Sea-level Pressure (MSLP) is 14.7 lbs/in² or 1013.25 mb.
- Other important levels of the atmosphere are
    - 850 mb ~1500 m
    - 700 mb ~3000 m
    - 500 mb ~5500 m
    - 300 mb ~9000 m
    - 200 mb ~11500 m
- The **jet stream** level is about 250 mb.
- **Density** is the amount of a quantity per unit area or volume.
- **Boyle's law** states that with temperature constant, pressure is directly proportional to density.
- **Charles' law** states that with pressure constant, temperature is inversely proportional to density.
- The **Ideal Gas Law** combines these two laws and use volume as the inverse of density to state **P=ρRT**, where R is a constant.
- A radiosonde is a package of instruments carried aloft by a weather balloon and radios data back to earth upper air observations.
- See http://weather.cod.edu/sirvatka/instruments.html and http://weather.cod.edu/notes/stnmodel.html for more information about weather instruments and station models.