Lecture 1 Atmospheric Composition and Structure.

TABLE 1.1 Composition of the Atmosphere Near the Earth's Surface (EOM)

Permanent Gases			Variable Gases			
Gas	*Symbol*	*Percent (by Volume) Dry Air*	*Gas (and Particles)*	*Symbol*	*Percent (by Volume)*	*Parts per Million (ppm)*
Nitrogen	N_2	78.08	Water vapor	H_2O	0 to 4	
Oxygen	O_2	20.95	Carbon dioxide	CO_2	0.036	360*
Argon	Ar	0.93	Methane	CH_4	0.00017	1.7
Neon	Ne	0.0018	Nitrous oxide	N_2O	0.00003	0.3
Helium	He	0.0005	Ozone	O_3	0.000004	0.04**
Hydrogen	H_2	0.00006	Particles (dust, soot, etc.)		0.000001	0.01–0.15
Xenon	Xe	0.000009	Chlorofluorocarbons (CFCs)		0.00000002	0.0002

*For CO_2, 360 parts per million means that out of every million air molecules, 360 are CO_2 molecules.

**Stratospheric values are about 5 to 12 ppm.

- Atmosphere primarily N_2, O_2, small quantities of other 'permanent' gases whose concentrations do not vary significantly over space or time. Trace permanent gases, except hydrogen (H), are inert.
- 'Variable' gases - concentrations vary with location, time due to exchange with sea, land surfaces, geological, biological and human activities.

Variable gases - H_2O and CO_2

- Moisture source: evaporation, plant transpiration.   sink: precipitation
- Warm air can hold much more water vapor:
  Tropics - Air is 2-4% water vapor by volume
  Poles (winter), high altitudes - Under 0.1%
- CO_2 largely biological in origin, cycled through ocean, rocks.
- CO_2 has risen 30% from 280 ppm in 1800 to over 375 ppm today, mainly due to fossil fuel burning.

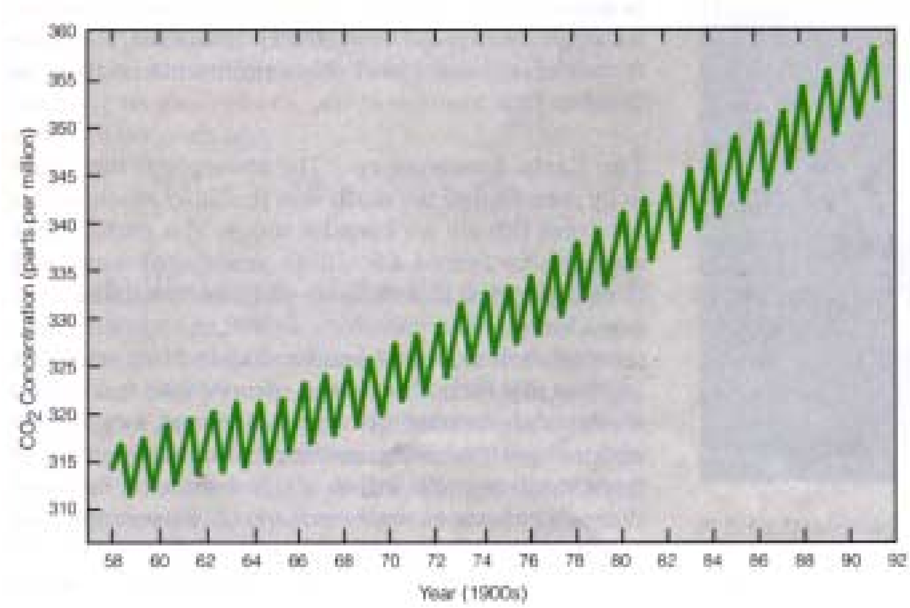
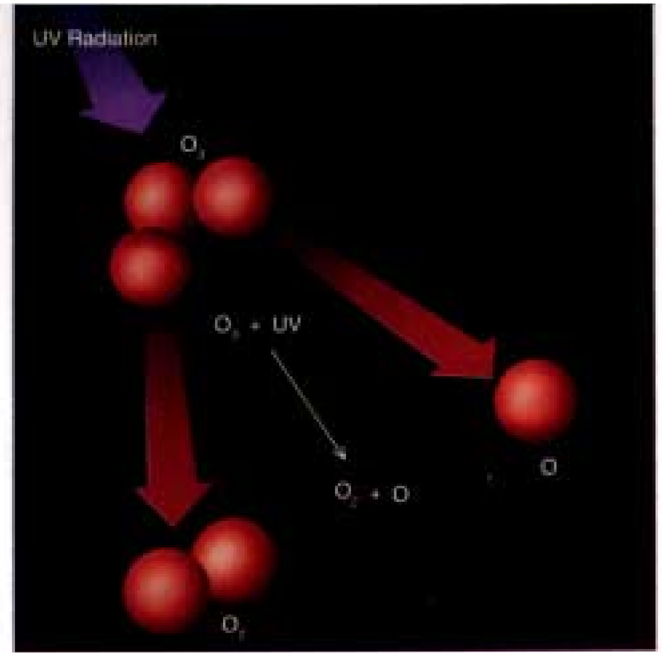


Figure 1.3 (EOM)
Measurements of CO_2 in parts per million (ppm) from 1958 through 1991 at Mauna Loa Observatory. Higher readings occur in winter when plants die and release CO_2 to the atmosphere. Lower readings occur in summer when more abundant vegetation absorbs CO_2 from the atmosphere.

- CO_2 also outgassed in volcanic eruptions. This may have helped maintain CO_2 at several times current concentrations 50-100 million years ago.

Ozone (O_3)

- At the surface, naturally occurring O_3 concentrations are very low (0.02-0.05 ppm). However, O_3 is main constituent of photochemical smog, and causes lung, plant irritant at levels above 0.1 ppm.
- 97% of ozone in upper atmosphere, mainly at heights above 20 km, sunlight splits oxygen molecules (O_2) into O atoms, which recombine with O_2 mole-cules to produce 'lots of' (10+ ppm) O_3 .
- Here, it shields surface life by absorbing UV and splitting ('photodissociating') into O_2 + O



EOM 1.10

- Ozone is also destroyed by nitric oxide (high altitude jet planes). Chlorine (CFCs) also destroys ozone in extreme cold - Antarctic ozone hole.

Air pressure

- Supports weight of air column above.
- At surface -

  Column 1 inch on side weighs 14.7 lb,

  Column 1 cm on side weighs 1013 g,

⇒Air pressure is 1013 g/cm^2= 1013 milli-bars (mb).

- Air pressure decreases with height, reflecting smaller mass (weight) of overly-ing air column.
- Only 50% of the mass of molecules in the atmosphere is above 5.5 km, so pressure at 5.5 km is 50% that at surface, or about 500 mb.
- Only 1% of mass above 30 km, where pressure is 10 mb, 1% of surface pressure.

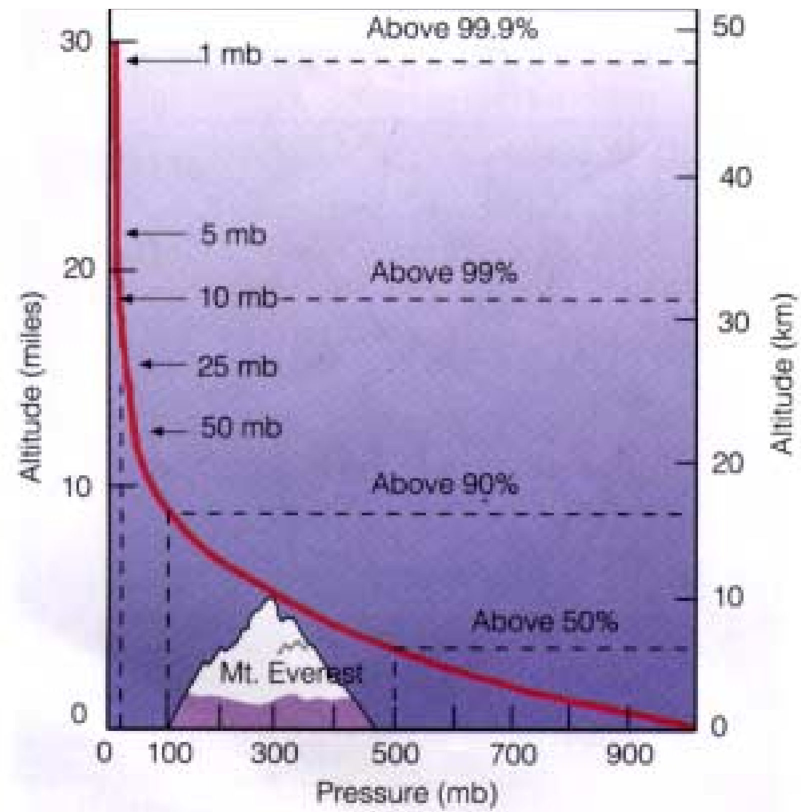
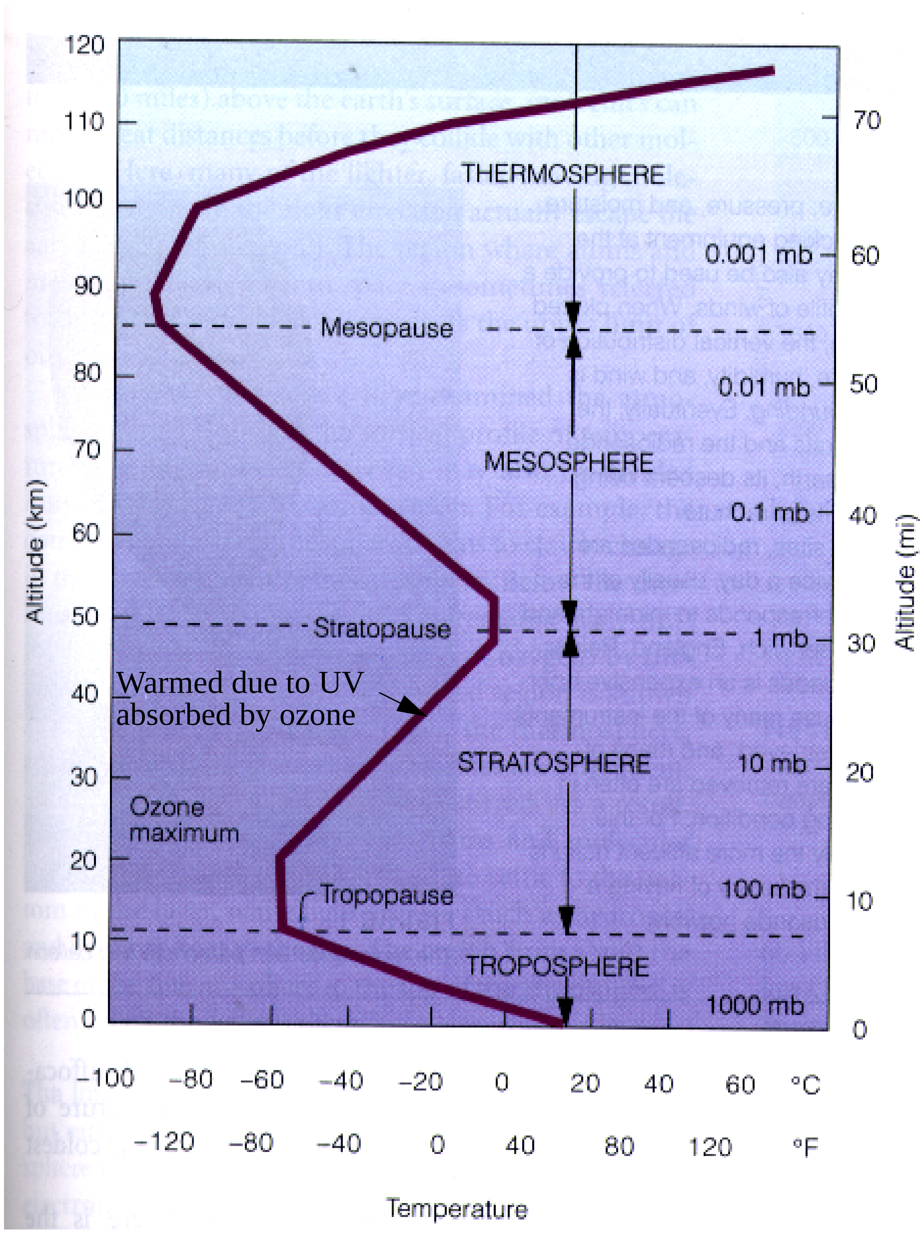


Figure 1.6 (EOM)
Atmospheric pressure decreases rapidly with height. Climbing to an altitude of only 5.5 km, where the pressure is 500 mb, would put you above one-half of the atmosphere's molecules.

Layers of the Atmosphere



The Outer Atmosphere

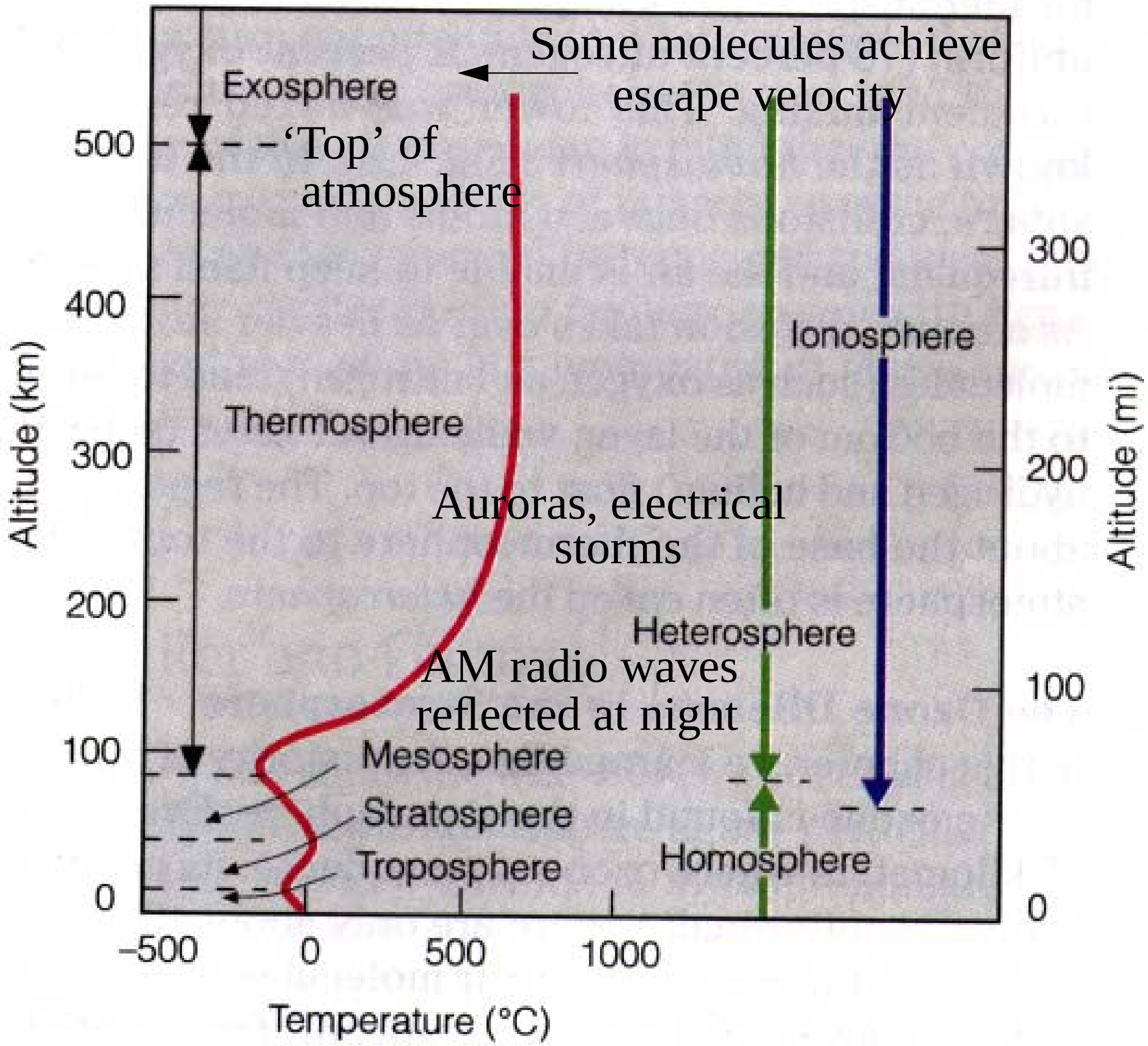


Figure 1.8 (EOM)
Layers of the atmosphere based on temperature (red line), composition (green line), and electrical properties (blue line).