Perfect gas law $P = \frac{1000R}{\bar{M}}\rho T = R_s \rho T$

Hydrostatic equation $\frac{dP}{dz} = -g\rho(z)$

Scale Height $P = P_0 \exp(-z/H)$ where

$$H = \frac{1000R\bar{T}}{g\bar{M}} = \frac{R_S\bar{T}}{g}$$

Adiabatic Lapse Rate $\frac{dT}{dz} = -\frac{g}{C_P}$

Parcel and Environmental viewpoints

Residence time $\tau = \text{Mass/Flux}$

Solar constant S; energy per unit area delivered by the Sun at earth orbit.

The Beer-Lambert Law $dI = -KNIdz$

Ozone layer creation by UV radiation; Destruction by free radical reactions.

$$\mathrm{ClO} + \mathrm{O_3} \longrightarrow \mathrm{ClO_2} + \mathrm{O_2}$$

$$\mathrm{ClO_2} + \mathrm{O} \longrightarrow \mathrm{ClO} + \mathrm{O_2}$$

Damage functions $D = \int_0^\infty E(\lambda)I(\lambda)d\lambda$

Energy balance of atmosphere

$$T_E^4 = S(1-a)/4\sigma$$

The Greenhouse effect Atmosphere lets through solar radiation, absorbs terrestrial radiation. $T_0 = T_E \sqrt[4]{2}$

Clausius-Clapeyron Equation

$$\frac{d\ln e_s}{dT} = \frac{L_S}{R_S(\mathrm{H_2O})T^2}$$

Humidity - specific, saturated, relative

- e depends on temperature since $e = \rho_v R_S T$
- q is independent of temperature (if there is no condensation) since $q = \frac{e}{P}\frac{M_v}{\bar{M}}$
- e_s depends on temperature (Clausius-Clapeyron equation)
- q_s depends on temperature and pressure
- Relative humidity depends on temperature ($RH = 100e/e_s$)

Water vapour in the air measured by a *wet bulb thermometer* or *dew-point meter*.

Evolution of rain drops nucleation using aerosol particles. Growth by diffusion then coalescence.

Lightning potential difference created by falling hailstones; leader (downwards) followed by upward return stroke.

Porosity of soil field capacity, permanent wilting point, available capacity

Water potential $\Psi = -(\text{depth} + \text{suction})$

Groundwater flow Darcy's Law $Q_W = -\kappa \frac{d\Psi}{dx}$

Forces on air gravity, pressure, coriolis, friction

Geostrophic wind $\frac{1}{\rho}\frac{dP}{dx} = (2\Omega \sin\phi)V$

Thermal Wind Equation $\frac{\Delta V_g}{\Delta z} = \frac{g}{f_c \bar{T}}\frac{d\bar{T}}{dx}$

Gradient Wind Equation $\frac{1}{\rho}\frac{dP}{dx} = \frac{V^2}{R} + f_c V$

Depressions and frontal systems origin, growth and decay.

Hurricanes and tornadoes life-cycle; geostrophic vs. cyclostrophic.

Global air circulation Combination of ”sea-breeze” effect and conservation of angular momentum. Polar, Ferrel and Hadley cells.