

EART164: Equations You Should Know (in addition to high school physics)

Basics

Ideal gas law $P\mu = \rho R_g T$ Hydrostatic equbm. $dP = -\rho g dz$

Isothermal scale height $H = R_g T / g \mu$ Mean free path $\lambda = \frac{m_{mol}}{\pi \rho r_{mol}^2}$

Energy and temperature

Equilibrium temp. $T_{eq} = \left(\frac{S(1-A)}{4\sigma\epsilon} \right)^{1/4}$ Moist adiabat $\frac{dT}{dz} = -\frac{g}{C_p + L_H \frac{dx}{dT}}$

Adiabat $P = c \rho^\gamma$ [$\gamma = C_p / C_v$]

Clouds and Dust

Clausius-Clapeyron $\frac{dP_s}{dT} = \frac{L_H P_s}{R_g T^2}$ Dust sinking time $t \approx \frac{\eta H}{g r^2 \Delta \rho}$

Radiative Transfer

Optical depth $\frac{\partial \tau}{\partial z} = \alpha \rho$ Greenhouse effect $T_s = T_{eq} \left(1 + \frac{3}{4} \tau_s \right)^{1/4}$

Stratosphere $T_0 = \frac{1}{2^{1/4}} T_{eq}$ Radiative diffusion $F = -\frac{16}{3} \frac{\sigma T^3}{\alpha \rho} \frac{\partial T}{\partial z}$

Time constant $t_{rad} = \frac{P C_p}{g \sigma T^3}$ Dust optical depth $\tau = \frac{3h\rho}{4r\rho_s}$