

HOMEWORK
Hydrostatics and Thermodynamics 1

Read Chapter 3 (Sections 3.1-3.3) of W&H

1. Calculate the virtual temperature of a parcel of air with at temperature of 25 C and a water vapor mixing ratio of 5 g kg⁻¹ and 10 g kg⁻¹. Using additional information about the maximum likely values of the water vapor mixing ratio on earth, estimate the maximum likely difference between the virtual temperature and the temperature in the earth's atmosphere. Where is this difference likely to be maximized? [2]

2. Using the hydrostatic equation and the ideal gas law, derive an expression for the ratio of the pressure to the surface pressure for an atmosphere in which the temperature decreases at a constant rate with height, i.e. $T(z) = T_0 - \Gamma z$.

[Hint: the integral $\int \frac{dx}{A - Bx} = -\frac{1}{B} \ln(A - Bx)$]

Given $T_0 = 280$ K, Γ = dry adiabatic lapse rate = 10 K km⁻¹, estimate the height at which the pressure falls to $1/e = 0.367$, of its surface value. Calculate the standard scale height and compare this with your answer. Why are they different? [4]

3. The average density of a layer between pressure levels of 850 hPa and 500 hPa is 0.92 kg m⁻³. If the geopotential height at 850 hPa is 1440 meters, calculate the geopotential height at 500 hPa. [2]

4. Explain how to determine whether a cyclone is a warm-core or cold-core storm using only a vertical cross section through the storm center showing constant pressure surfaces. [2]