1. Find θ_e for each sample. If they are equal, then the air is likely the same since θ_e is conserved

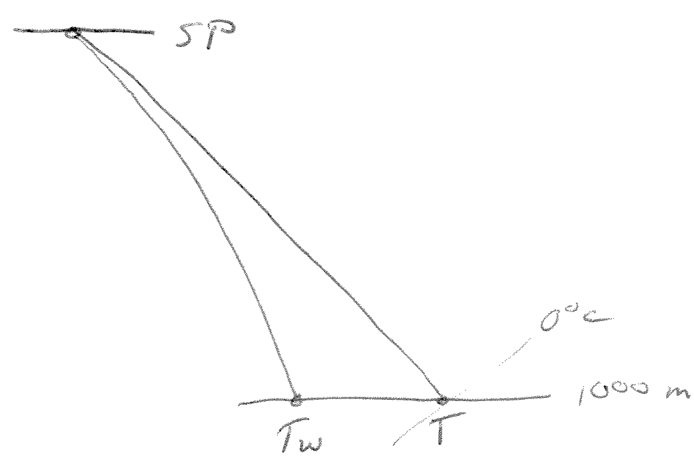
a) $\theta_e = 324$ K for both

$\therefore$ The air is the same

b) $\theta_e = 331$ K.

$\therefore$ This is not the same air.

2. Compute using the eq. 6.8a, setting $r_v = 0$. Also check with skew-T, as illustrated below.



$T - T_w \simeq 6°C$

3. a) $T = 310\ K$, $T_d = 280\ K$

$$T - T_d = 30\ K = 54\ °F$$

$$T - T_d = 4.25 \times 10^{-4}\, T T_d (-\log_{10} f)$$

$$\Rightarrow f = .15$$

Rule: $(T - T_d) * 3.2 = 172.8$

$\Rightarrow$ Does not work <u>way too low</u>

b) $T = 250\ K$, $T_d = 248\ K$

$$f = 84\%$$

$$T - T_d = 2 \cdot 1.8 = 3.6\ °F$$

Rule: $(T - T_d) * 3.2 = 3.6(3.2) = 11.5$

$$\Rightarrow RH = 100 - 11.5 = 88.5\%$$

<u>too high</u>

Rule works better for values of T/T_d near 280–290 K.

4. $$e_s = Ae^{-B/T}$$

$$\frac{\partial e_s}{\partial T} = Ae^{-B/T}\frac{\partial}{\partial t}\left(\frac{-B}{T}\right)$$

$$= Ae^{-B/T}\left(\frac{B}{T^2}\right) = \frac{AB}{T^2}e^{-B/T}$$

$$\frac{\partial^2 e_s}{\partial T^2} = \frac{\partial}{\partial T}\left(\frac{AB}{T^2}e^{-B/T}\right)$$

$$= \frac{AB}{T^2}e^{-B/T}\left(\frac{B}{T^2}\right) + \frac{-2AB}{T^3}e^{-B/T}$$

$$= \frac{AB^2}{T^4}e^{-B/T} + \frac{-2AB}{T^3}e^{-B/T}$$

$$= \frac{AB}{T^3}e^{-B/T}\left(\frac{AB}{T} - 2\right)$$

> 0 (positive curvature)

for $\frac{AB}{T} > 2$ (which is the case)

5. a) $e = e_s \cdot f$

$$= \frac{17.67\,T}{T+243.5}(0.75)$$

$$= 2376 \text{ Pa.}$$

b) $$\rho_v = \frac{e}{R_v T} = \frac{2376}{(461.5)(298.15)} = 0.0173 \text{ kg m}^{-}$$

c) $$r_v = \varepsilon \frac{e}{p-e} = 0.622 \frac{2376}{90000-2376}$$

$$= 0.0169 \text{ kg kg}^{-1}$$

d) $$q_v = \varepsilon \frac{e}{p-(1-\varepsilon)e} = 0.622 \frac{2376}{90000-(1-0.622)2376}$$

$$= 0.0166 \text{ kg kg}^{-1}$$

e) $$\rho_d = \frac{p-e}{R_d T} = 1.02 \text{ kg m}^{-3}$$

f) $$T_v = T(1+0.608\,r_v)$$

$$= 298.15(1+0.608(0.0169))$$

$$= 301.2 \text{ K}$$

g) $T_{iw} = T - \left(\frac{L_{lv}}{c_p}\right)\left[\frac{e}{p} A e^{-B/T_{iw}} - r_v\right]$

$\simeq 293 \text{ K}$

h) $T_{aw} \approx 22\ ^\circ\text{C}$ (graph)

i) $$T_{sp} = \frac{1}{\frac{1}{T-55} - \frac{\ln f}{2840}} + 55.$$

$$= \frac{1}{\frac{1}{(298.15-55)} - \frac{\ln(0.75)}{2840}} + 55 = 292.3 \text{ K}$$

l ~~g~~) $T_{ae} = T \exp\left(\frac{L_{lv} r_v}{c_p T}\right)$

$= 340 \text{ K}$

j ~~k~~) $\theta = T\left(\frac{1000}{p}\right)^{\frac{R_d}{c_p}(1-0.28 r_v)} = 307.2 \text{ K}$

k) $T_{ie} = T + \frac{L_{lv} r_v}{c_p} = 339.2 \text{ K}$

m) $\theta_e = \theta \exp\left[\left(\frac{3.376}{T_{sp}} - 0.00254\right) r_v (1 + 0.81 r_v)\right]$

$= 358.5 \text{ K}$

n) $\theta_w \doteq 25.5$ C (graph)

o) $\chi = \rho_m \left[r_v - r_{vs}(T_{500}, p_{500}) \right]$

$$= \frac{50000}{\underbrace{T_{500}}_{275} (1 + 0.61 \underbrace{r_{v500}}_{0.0074}) R_d} \left[0.0169 - \overset{0.0074}{r_{v500}} \right]$$

$$\doteq 6 \quad \cancel{k}g \ m^{-3}$$