EAS270, "The Atmosphere" Quiz 2 3 Nov., 2014

Professor: J.D. Wilson Time available: 20 mins Value: 10%

Instructions: Choose the best (or most logical) option, and use a pencil to mark that choice on the scantron form. **Eqns/data given at back**. You may keep this quiz.

1. If vapour pressure $e = 1.1$ kPa and the temperature $T = 23^oC$, what is the absolute humidity ρ_v?
   (a) $8 \times 10^{-3}\ \mathrm{kg\,m^{-3}}$ ✓✓[81% correct]
   (b) $8 \times 10^{-6}\ \mathrm{kg\,m^{-3}}$
   (c) $0.1\ \mathrm{kg\,m^{-3}}$
   (d) $1 \times 10^{-4}\ \mathrm{kg\,m^{-3}}$
   (e) $8\ \mathrm{g\,kg^{-1}}$

2. What is the relative humidity of air having temperature $T = 6^oC$ and vapour pressure $e = 0.7$ kPa?
   (a) 95%
   (b) 75% ✓✓[84% correct]
   (c) 65%
   (d) 55%
   (e) 45%

3. What option is closest to the dewpoint T_d of air whose temperature and relative humidity are $T = 19^oC$ and 65%?
   (a) 28°C
   (b) 23°C
   (c) 19°C
   (d) 12°C ✓✓[79% correct]
   (e) 4°C

4. Referring to Figure (1), which option best describes the buoyancy force F_B that will act on a parcel of air that rises from the surface into the mixed layer?
   (a) $F_B = 0$, no buoyancy force
   (b) $F_B > 0$, downward buoyancy force
   (c) $F_B > 0$, upward buoyancy force ✓✓[65% correct]
   (d) $F_B < 0$, downward buoyancy force
   (e) $F_B < 0$, upward buoyancy force

5. Referring to Figure (2), which statement is **false** or **without justification**?
   (a) the LFC lies at the level marked "z" ✓✓[67% correct]
   (b) this is an idealized summer daytime scenario
   (c) the middle layer is well mixed
   (d) the surface layer is absolutely unstable
   (e) the upper layer is an inversion

6. Referring to Figure (3), which answer best approximates the total number density of CCN (cm^{-3})? Hint: area under the "curve."
   (a) 10
   (b) 50
   (c) 100
   (d) 200
   (e) 1200 ✓✓[60% correct]

7. Referring to the sounding (Fig. 4), what pressure and temperature correspond to the point of intersection of isotherms and isobars within the heavy circle **O**?
   (a) 300 Pa, 18°C
   (b) 300 hPa, 18°C
   (c) 300 kPa, 18°C
   (d) 300 hPa, −10°C
   (e) 300 hPa, −25°C ✓✓[91% correct]

8. Referring to the sounding (Fig. 4), what is the correct static stability category for the layer whose upper and lower boundaries are those of the drawn box?
   (a) absolutely unstable
   (b) absolutely stable ✓✓[38% correct; ELR is weaker than the SALR]
   (c) conditionally unstable
   (d) neutral with respect to unsaturated adiabatic motion
   (e) neutral with respect to saturated adiabatic motion

9. Again referring to the sounding (Fig. 4), what is the correct static stability category for the layer below 700 hPa?
   (a) absolutely unstable
   (b) absolutely stable
   (c) conditionally unstable
   (d) neutral with respect to unsaturated adiabatic motion ✓✓[63% correct]
   (e) neutral with respect to saturated adiabatic motion

10. Again referring to the sounding (Fig. 4), which level is closest to the LCL for lifted surface parcels?
   (a) 925 hPa
   (b) 850 hPa
   (c) 700 hPa ✓✓[88% correct]
   (d) 500 hPa
   (e) 250 hPa

Equations & Data.

- 1 kPa =10 hPa = 1000 Pa, T [K] = T [°C] + 273.15
- $e = \rho_v \; R_v \; T$, The ideal gas law for water vapor. e [Pascals], pressure; ρ_v, [kg m^{-3}] the absolute humidity (ie. vapor density); T [Kelvin], the temperature; and $R_v = 462$ [J kg^{-1} K^{-1}], the specific gas constant for water vapor.
- $F_B = g\;(T_p - T)/T$ **or** $F_B = \; g\;(\theta_p - \theta)/\theta$. Alternative expressions for the buoyancy force on a parcel whose temperature and potential temperature are (T_p, θ_p) at a level where the environmental temperature and potential temperature are (T, θ). The denominator must be expressed in Kelvin.

Table 1: Equilibrium vapour pressure $e_s(T)$ [hPa] versus temperature T [°C]. Figure cited applies to equilibrium over a plane surface of water where $T \geq 0$°C, or of ice where $T < 0$°C.

T	$e_s(T)$	T	$e_s(T)$	T	$e_s(T)$	T	$e_s(T)$	T	$e_s(T)$	T	$e_s(T)$	T	$e_s(T)$	T	$e_s(T)$
-10	2.60	-5	4.02	0	6.11	5	8.72	10	12.27	15	17.04	20	23.37	25	31.67
-9	2.84	-4	4.37	1	6.57	6	9.35	11	13.12	16	18.17	21	24.86	26	33.61
-8	3.10	-3	4.76	2	7.05	7	10.01	12	14.02	17	19.37	22	26.43	27	35.65
-7	3.38	-2	5.17	3	7.58	8	10.72	13	14.97	18	20.63	23	28.09	28	37.80
-6	3.69	-1	5.62	4	8.13	9	11.47	14	15.98	19	21.96	24	29.83	29	40.06

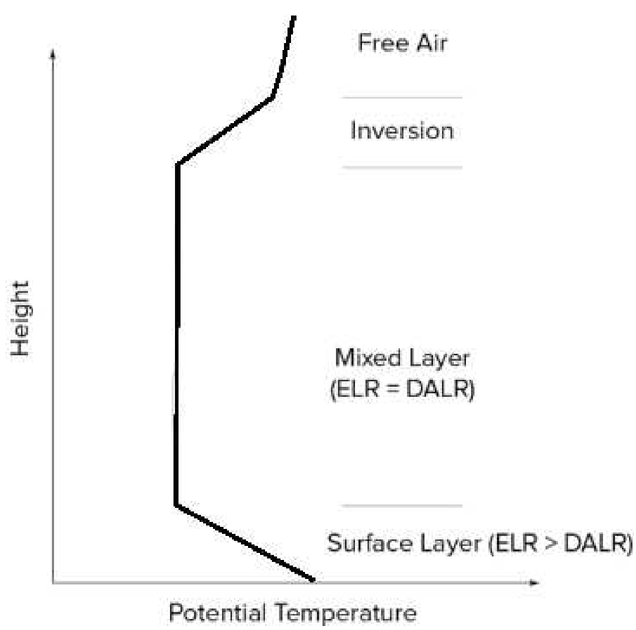

Figure 1: Idealized summer daytime profile of potential temperature θ. (Ross's Figure 8.29).

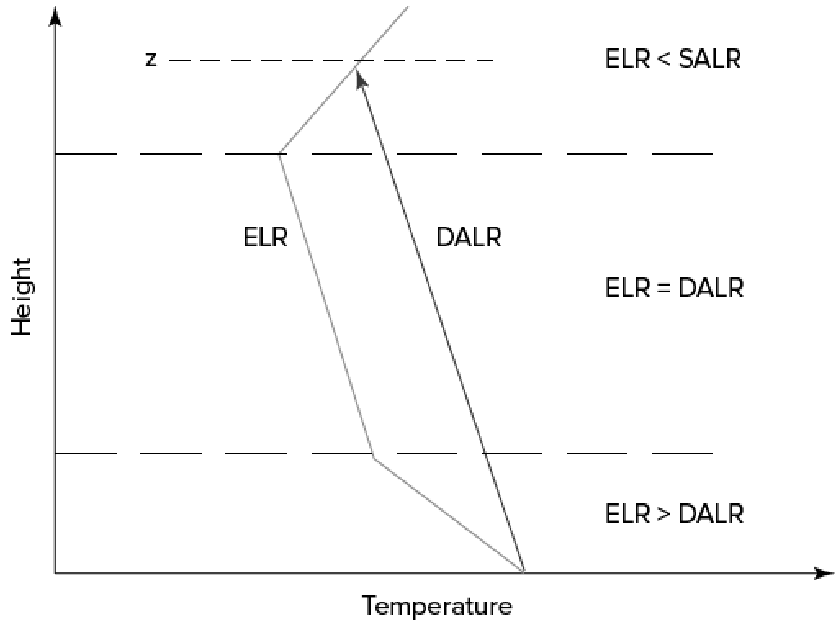

Figure 2: Idealized three-layer temperature profile. **Assume the line with the arrow gives the temperature of a parcel as it rises from the surface**. (Ross's Figure 8.21).

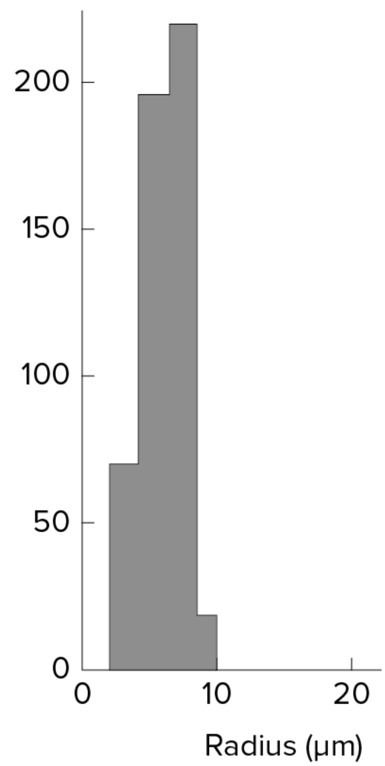

Figure 3: Idealized size distribution of CCN particles in continental air. The unit on the y-axis is $\mathrm{cm}^{-3}\,\mu\mathrm{m}^{-1}$, i.e. number of CCN per cubic centimetre per μm interval of radius. (Ross's Figure 9.5).

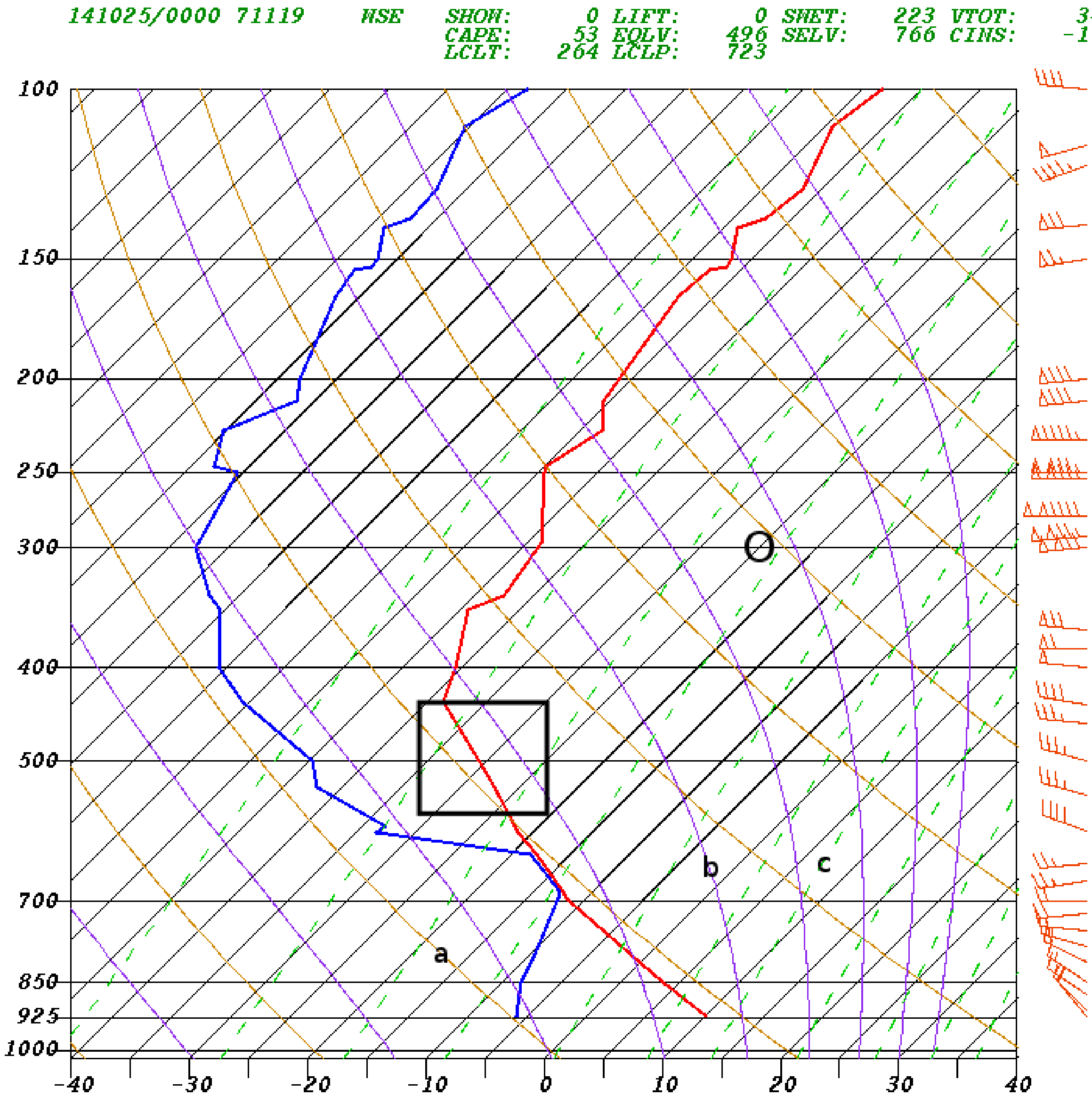

Figure 4: Stony Plain sounding, 00 UTC 25 October 2014, plotted on the skew-T diagram. Unsaturated adiabats (e.g. **a**), saturated adiabats (e.g. **b**) and isotherms are all solid lines; isohumes (e.g. **c**) are dashed lines.