EAS270, "The Atmosphere" Quiz 2 17 Oct, 2005

Professor: J.D. Wilson Time available: 25 mins Potential Value: 10%

Instructions: For all 16 questions, choose what you consider to be the best (or most logical) option, and use a pencil to mark that choice on the answer form. **Eqns/data given at back**. You may keep this quiz.

1. In a pristine (ie. clean) atmosphere, the sky colour is attributable to ____

   (a) preferential atmospheric scattering of red wavelengths
   (b) preferential atmospheric scattering of blue wavelengths ✓✓
   (c) preferential atmospheric absorption of red wavelengths
   (d) preferential atmospheric absorption of blue wavelengths
   (e) Mie scattering by air molecules

2. On a clear, sunny day with light winds, maximum surface temperature occurs ____

   (a) At local solar noon, when $K\downarrow$ is maximum
   (b) When $L\downarrow$ is maximum
   (c) When $L\uparrow$ is minimum
   (d) When net radiation Q^* crosses zero in the upward direction
   (e) At the afternoon transition (through zero) of the net radiation $Q^* = K^* + L^*$ ✓✓

3. Suppose on a particular sunny summer afternoon the net radiation was $Q^* = 500$ W m^{-2}, and the sensible and latent heat fluxes were $Q_H = 180, Q_E = 300$ W m^{-2}. Neglecting any storage term, the soil heat flux Q_G was therefore ____ W m^{-2}

   (a) -980
   (b) 20 ✓✓
   (c) 120
   (d) 480
   (e) 980

4. The diurnal (daily) range in temperature normally ____

   (a) is greatest in the mid-stratosphere
   (b) is greatest at the tropopause
   (c) is greatest at the ground surface ✓✓
   (d) increases with increasing distance into the soil
   (e) is constant for any given location and season

5. In an inversion layer of the atmosphere, vertical motion is ____ and the direction of sensible heat transfer is ____ the ground.

   (a) Suppressed; towards ✓✓
   (b) Enhanced; towards
   (c) Enhanced; away from
   (d) Suppressed; away from
   (e) None of the above

6. We expect the wind near ground to diminish overnight because ____

   (a) Unstable temperature stratification suppresses vertical exchange of air parcels, thus decoupling the surface air from the driving winds aloft
   (b) Stable temperature stratification (inversion) enhances vertical exchange of air parcels, thus decoupling the surface air to the driving winds aloft
   (c) Stable temperature stratification (inversion) suppresses vertical exchange of air parcels, thus decoupling the surface air from the driving winds aloft ✓✓
   (d) Unstable temperature stratification enhances vertical exchange of air parcels, thus decoupling the surface air to the driving winds aloft
   (e) The air is loaded with dew, thus heavier, and so it slows down

7. On earth's equator, the ground rotates about the local vertical at a rate of ____ [rad day^{-1}] and the Coriolis parameter f ____

   (a) 0; is zero ✓✓
   (b) $\pi/4$; equals the earth's rotation rate
   (c) 2π; equals the earth's rotation rate
   (d) 360; is zero
   (e) 1370; equals the solar constant

8. "Cross-isobar flow" occurs in the ____ layer of the atmosphere. That flow is oriented ____ a center of Low pressure, and results in ____ vertical motion

   (a) Tropospheric; away from; ascending
   (b) Geostrophic; away from; descending
   (c) Geostrophic; into; ascending
   (d) Friction; into; descending
   (e) Friction; into; ascending ✓✓

9. According to the "Geostrophic-wind" and "Gradient-wind" scientific models for the winds in the free atmosphere, the wind should blow ____ to pressure contours, with a speed that is ____ to the distance between the contours.

   (a) parallel; inversely proportional ✓✓
   (b) parallel; proportional
   (c) perpendicular; inversely proportional
   (d) perpendicular; proportional
   (e) adjacent; indifferent

10. A parcel of air at the 700 mb level which is moving at constant speed parallel to circular isobars ____

   (a) Experiences no centripetal acceleration
   (b) Is not subject to the Coriolis force
   (c) Is not subject to the pressure-gradient force
   (d) Accelerates towards the centre of low pressure ✓✓
   (e) Accelerates along the local tangent to the isobars

11. Which of the following air properties would normally increase as you travelled upward through the summer, daytime Planetary Boundary Layer (Friction Layer)?

   (a) air density
   (b) air pressure
   (c) air temperature
   (d) wind speed ✓✓
   (e) humidity

For the remaining questions, please refer to the attached charts.

12. The height gradient $\Delta h/\Delta x$ in the region of the NE corner of Alberta is about ____

   (a) 2.5 x 10^{-4} Pa m^{-1}
   (b) 2.5 x 10^{-4} m m^{-1} ✓✓
   (c) 60 dam km^{-1}
   (d) 1221 Pa
   (e) 0.25 m m^{-1}

13. Based on this calculated the height gradient and assuming geostrophic flow, the 500 mb windspeed at the NE corner of Alberta (latitude 60^o N) should be about ____ m s^{-1}

    (a) 2.5
    (b) 5
    (c) 10
    (d) 20 ✓✓
    (e) 40

14. From the 850 mb analysis, this region (ie. NE corner of Alberta and NW Territories further NE) is experiencing

    (a) warm advection ✓✓
    (b) cold advection
    (c) NW wind
    (d) saturated air ($T_d = 10^o$ C exceeds $T = 3^o$ C)
    (e) warming of 4.1^o C since the previous observation

15. The feature visible in the 850 mb flow contours in west-central and south-western Alberta is called a/n ____ . It can be attributed to ____

    (a) isotherm; temperature advection
    (b) ridge; enhanced friction over the Rockies
    (c) lee trough; enhanced friction over the Rockies ✓✓
    (d) lee valley; temperature advection
    (e) lee cyclone; cyclogenesis

16. At Stony Plain the temperature and dewpoint at 700 mb were about ____ ^{o}C

    (a) −18; −27
    (b) 0; +1
    (c) 0; −22 ✓✓
    (d) +14; +1
    (e) −22; 0

Equations and Data.

- $Q^* \ = \ Q_H \ + Q_E \ + Q_G \ + Q_S$

  The surface energy balance. All fluxes are in [W m^{-2}]. Q^* the net radiation, positive if directed towards the ground surface; Q_H, Q_E the sensible heat flux and the latent heat flux, positive if directed away from the ground surface; Q_G the soil heat flux, positive if directed away from the ground surface; Q_S, the storage term. The Bowen ratio $B = Q_H/Q_E$.

- $Q^* = \ K^* \ + L^* \ = K \downarrow - K \uparrow + L \downarrow - L \uparrow$

  The surface radiation balance. All fluxes are in [W m^{-2}]. $K \downarrow, K \uparrow$, the incoming and outgoing solar fluxes (net solar, $K^* = K \downarrow - K \uparrow$); and $L \downarrow, L \uparrow$, the incoming and outgoing longwave fluxes (net longwave, $L^* = L \downarrow - L \uparrow$).

- $V = \frac{g}{f} \ \frac{\Delta h}{\Delta x}$

  The Geostrophic wind equation. Δh [m], the change in height of a constant pressure surface over distance Δx [m] normal to the height contours; $f \ = \ 2\Omega \ \sin \phi$ [s^{-1}] the Coriolis parameter (where $\Omega = 2\pi/(24\text{x}60\text{x}60) = 7.27\text{x}10^{-5}$ s^{-1} is the angular velocity of the earth, and ϕ is latitude); $g \sim 10$ [m s^{-2}] acceleration due to gravity.

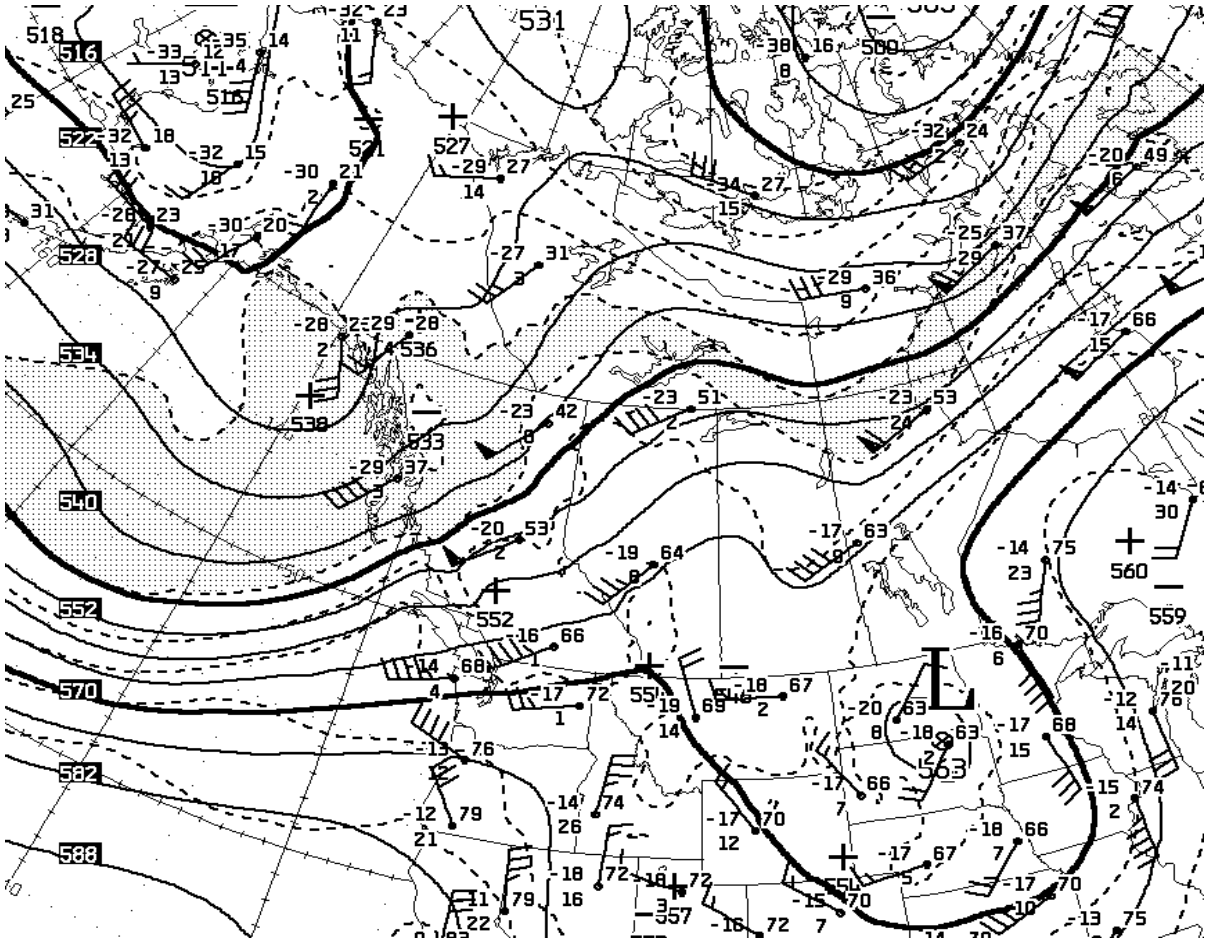

Figure 1: 500 mb analysis. 12Z Oct 12, 2005.

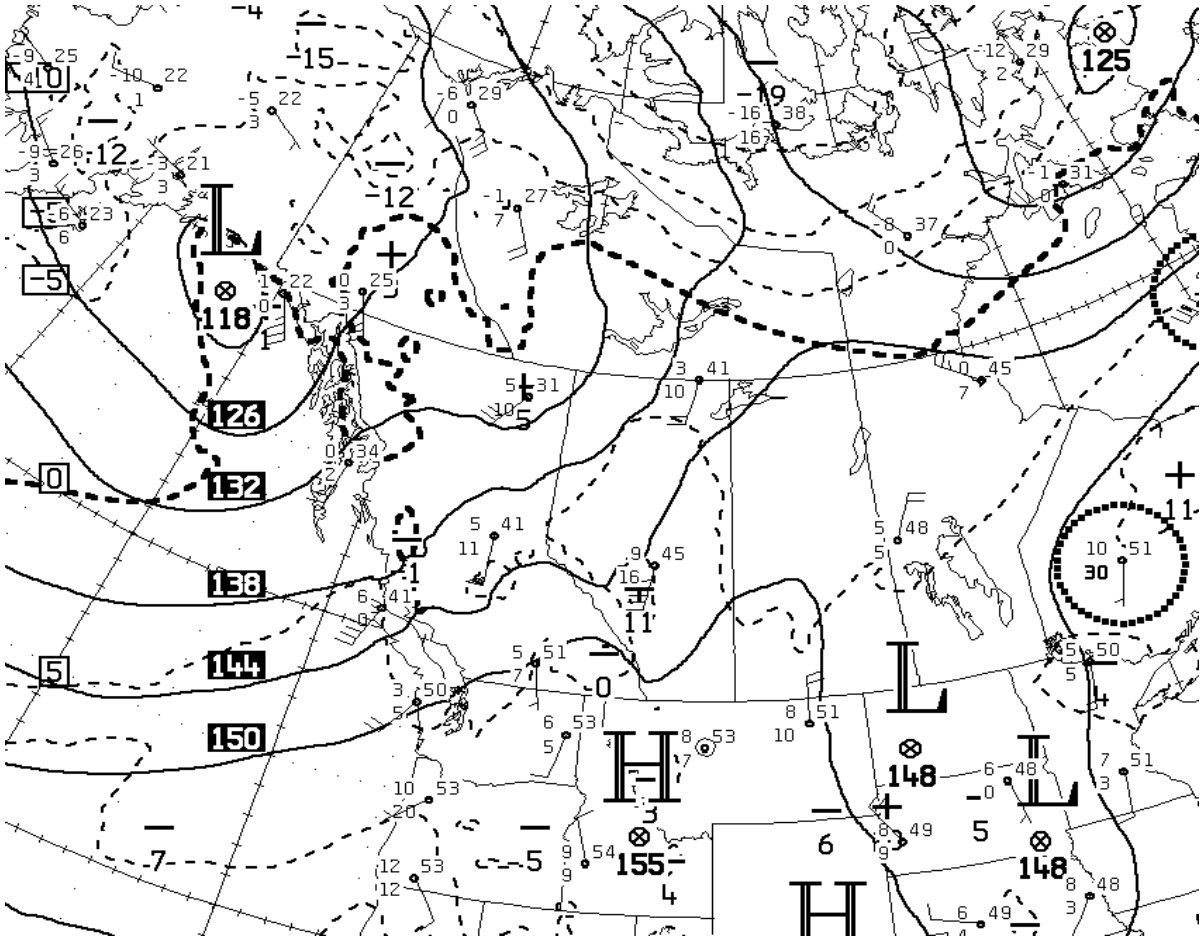

Figure 2: 850 mb analysis. 12Z Oct 12, 2005.

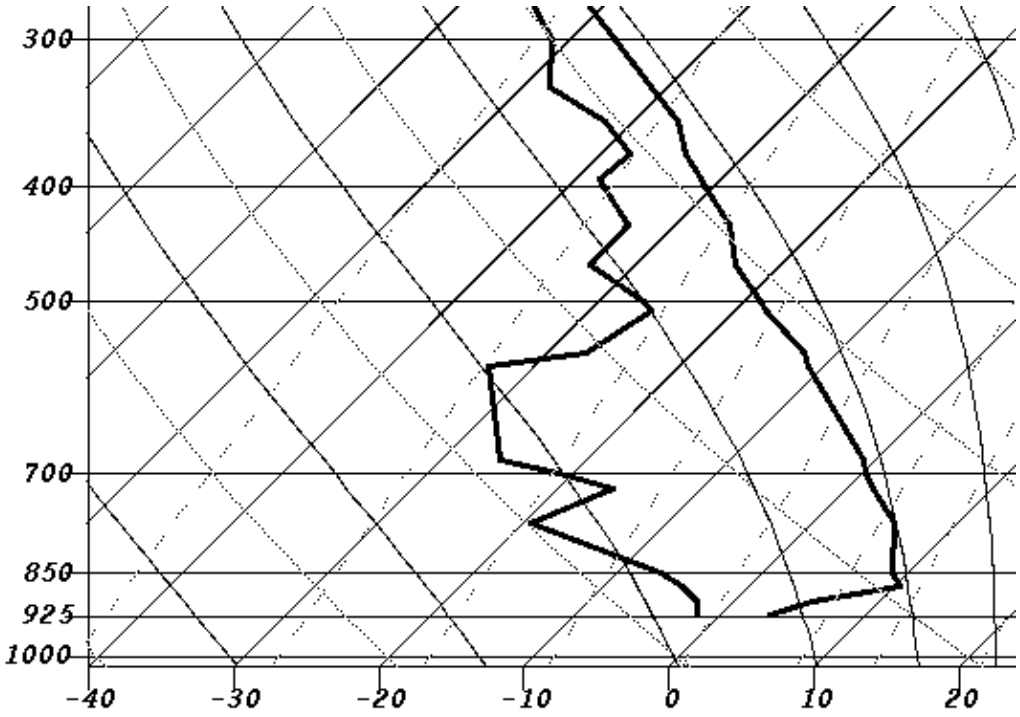

Figure 3: Skew T - log P diagram. Stony Plain, 12Z Oct 12, 2005.