EAS270, "The Atmosphere" Quiz 2 13 Oct., 2010

Professor: J.D. Wilson Time available: 15 mins Potential Value: 10%

Instructions: For all 12 questions, please 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. The depth of the planetary boundary layer is largest over ____ ground during ____ winds and ____ heat flux (Q_H).

   (a) rough; light; strong upward
   (b) rough; strong; strong upward ✓✓[63% answered correct; Slide 4, Lecture 9]
   (c) smooth; light; strong downward
   (d) smooth; strong; strong upward
   (e) frozen; light; strong downward

2. According to the Geostrophic model, the net force acting on air blowing at constant speed parallel to straight pressure (or height) contours is ____

   (a) Oriented in the direction of the wind
   (b) Oriented perpendicular to the wind
   (c) Equal to the Coriolis force
   (d) Zero ✓✓[41% answered correct; Slide 16, Lecture 11; Sec 4-5 p117-118]
   (e) Non-zero but constant

3. In the free atmosphere "Supergeostropic flow" occurs in the region of ____ pressure systems, with the magnitude of the Coriolis force ____ the magnitude of the pressure gradient force.

   (a) cyclonic; exceeding
   (b) cyclonic; being less than
   (c) anticyclonic; exceeding ✓✓[38% answered correct; p120]
   (d) anticyclonic; being less than

4. On a typical sunny summer day at noon the temperature is ____ at ground than at a height of 10 metres. This is called ____ stratification and it ____ vertical mixing.

   (a) Warmer; unstable; enhances ✓✓[73% answered correct; Slide 12 Lecture 8]
   (b) Cooler; stable; enhances
   (c) Warmer; stable; inhibits
   (d) Cooler; unstable; inhibits

5. Suppose that on a certain sunny summer afternoon the net radiation over a flat field of bare soil is $Q^* = 500$ W m^{-2}, and the sensible and latent heat fluxes are $Q_H = 180$, $Q_E = 300$ W m^{-2}. The soil heat flux Q_G must be ____

   (a) 980 W m^{-2}
   (b) 480 W m^{-2}
   (c) 120 W m^{-2}
   (d) 20 W m^{-2} ✓✓[94% answered correct; Slide 7, Lecture 7]
   (e) −980 W m^{-2}

6. The mechanism by which a strong wind tends to diminish the daily temperature range is that ____

   (a) wind tends to reduce the magnitude of the net shortwave radiation K^*
   (b) wind tends to reduce the magnitude of the net longwave radiation L^*
   (c) a (consequently) deeper mixed layer absorbs the daytime gain/nighttime loss of radiant energy ✓✓[67% answered correct; p81 and Slide 4, Lecture 9]
   (d) wind tends to reduce the magnitude of the net allwave radiation $Q^* \equiv K^* + L^*$

7. Consider the magnitude of the atmospheric pressure decrease ΔP between sea-level (height $z = 0$), and a point overhead at a height of 1 kilometre above sea-level ($z = 1000$ m). In the northern hemisphere winter, ΔP is ____

   (a) larger at the north pole than at the equator ✓✓[61% answered correct; pp112-113; also Slide 10, Lecture 10; Slide 5, Lecture 11]
   (b) smaller at the north pole than at the equator
   (c) the same at the north pole as at the equator
   (d) negative
   (e) zero

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) Geostrophic; away from; descending
   (b) Geostrophic; into; ascending
   (c) Tropospheric; away from; ascending
   (d) Friction; into; descending
   (e) Friction; into; ascending ✓✓[44% answered correct; p122; Slide 21, Lecture 11]

9. A parcel of air has pressure P, temperature T, vapor pressure e, and dewpoint temperature T_d. Which of the following pairs of numbers would **not** permit you to compute its relative humidity?

   (a) T_d, e ✓✓[31% answered correct; Slides 12-15, Lecture 12]

   (b) T, e

   (c) T, T_d

10. Which humidity variable is unchanged during vertical motion of an unsaturated parcel?

    (a) relative humidity

    (b) specific humidity ✓✓[46% answered correct; p138 and Slide 6, Lecture 12]

    (c) absolute humidity

    (d) dewpoint

    (e) vapour pressure

For the remaining questions, please refer to Figure (1).

11. The Fort St. John radiosonde station (YSM) on the northern border of Alberta has provided no wind report. Based on the Geostrophic model one may confidently assume this reflects equipment malfunction; of the specifications given below, the best guess for the 700 hPa wind at YSM is ____

    (a) WSW with a speed less than 10 $\mathrm{m\,s^{-1}}$

    (b) ENE with a speed less than 10 $\mathrm{m\,s^{-1}}$

    (c) WSW with a speed of about 20 $\mathrm{m\,s^{-1}}$ ✓✓[57% answered correct; inference from Ch4]

    (d) ENE with a speed of about 20 $\mathrm{m\,s^{-1}}$

    (e) SSE with a speed of about 20 $\mathrm{m\,s^{-1}}$

12. The height of the 700 hPa surface at YSM was ____ and the relative humidity at that height was about ____ .

    (a) 860 m; 90%

    (b) 860 dam; 90%

    (c) 86 dam; 40%

    (d) 286 dam; 40%

    (e) 286 dam; 90% ✓✓(RH=100 $e_s(-10)/e_s(-9)$)[41% answered correct; RH calculation covered Lecture 12]

Equations and Data.

- one full barb on the wind vector corresponds to about 5 m s^{-1}
- N=0 or 360, NNE=22.5, NE=45, ENE=67.5, E=90, ESE=112.5, SE=135, SSE=157.5, S=180, SSW=202.5, SW=225, WSW=247.5, W=270, WNW=292.5, NW=315, NNW=337.5

  The sixteen so-called "cardinal points" of the compass, given alphanumerically and as an angle measured clockwise around the circle. A coarser eight-point subdivision is N, NE, E, SE, S, SW, W, NW; and the four cardinal points are of course N, E, S, W

- $\frac{\Delta P}{\Delta z} = -\rho\, g$

  The hydrostatic law. ΔP [Pascals], the change in pressure as one ascends a distance Δz [m]; ρ [kg m^{-3}] the air density; $g \sim 10$ [m s^{-2}] acceleration due to gravity.

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

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

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

  Surface energy balance on a reference plane at the base of the atmosphere, all fluxes in [J m^{-2} s^{-1}]. Q^* the net radiation, positive if directed towards the surface; Q_H, Q_E the sensible and the latent heat fluxes, positive if directed from the surface towards the atmosphere; Q_G the 'soil' heat flux, positive if directed from the surface into ground/lake/ocean. The latent heat flux is related to the vertical flux of water vapour E by the relationship $Q_E = L_v E$, where L_v [J kg^{-1}] is the latent heat of vapourization

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

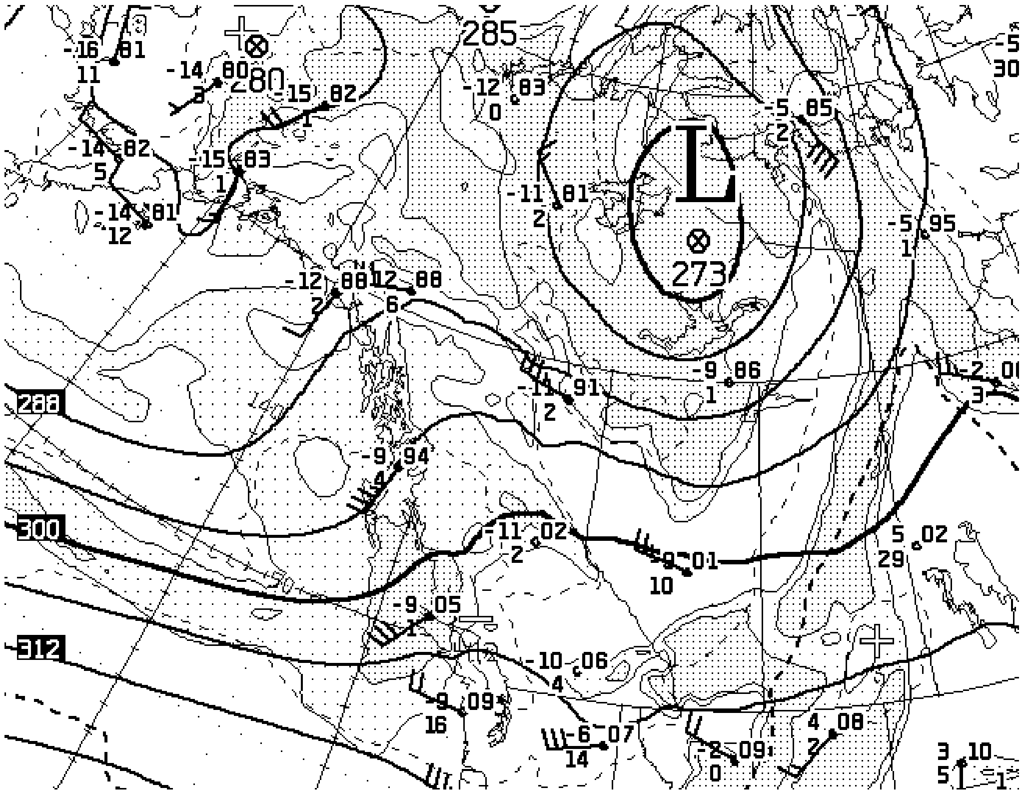

Figure 1: CMC 700 hPa analysis, 12Z Oct. 11, 2010. Fort Smith (YSM) is the station on the northern border of Alberta. The densest stippling indicates $T - T_d \leq 2^{\circ}$C.

Optional Anonymous Feedback to the Instructor

If you wish, please comment on the effectiveness of the course organization and the teaching style, identifying any problems and making suggestions for improvements. (Please place your feedback in the box provided at the end of class)