EAS270, "The Atmosphere" Quiz 1 22 Sept., 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. Suppose you are at a height in Earth's atmosphere where the pressure $P = 100$ hPa. Approximately what fraction of the atmosphere's mass lies beneath your elevation?
   (a) 1%
   (b) 10%
   (c) 50%
   (d) 90%
   (e) 99%

2. Which are the two most abundant permanent (or "constant") gases in earth's troposphere?
   (a) H_2O, N_2
   (b) N_2, O_2
   (c) N_2, CO_2
   (d) O_2, CO_2
   (e) Ar, CO_2

3. Which alternative or more basic MKS unit is **not** a correct decomposition of the Watt (i.e. MKS unit for power)?
   (a) $\mathrm{J\,s^{-1}}$
   (b) $\mathrm{N\,m\,s^{-1}}$
   (c) $\mathrm{m^2\,s^{-2}}$
   (d) $\mathrm{kg\,m^2\,s^{-3}}$

4. Let $C(\mathbf{x}, t)$ represent the proportions (by volume) of a gas at the point $\mathbf{x}$ in the troposphere at time t; let ΔC be the magnitude $|C(\mathbf{x}_1, t) - C(\mathbf{x}_2, t)|$ of the largest difference in C between any two points in the troposphere at t; and let $\overline{C}$ denote the global annual average tropospheric value of C for this gas. Which of the following naturally-occuring atmospheric gases is **most variable**, i.e. exhibits the largest ratio $\Delta C/\overline{C}$?
   (a) water vapour
   (b) carbon dioxide
   (c) argon
   (d) oxygen
   (e) nitrogen

5. In relation to the atmospheric reservoir and the biogeochemical cycles of nitrogen, oxygen, carbon dioxide and methane, which of the statements below is **false**?
   (a) nitrogen fixation is a sink for N_2
   (b) combustion is a sink for O_2 and a source for CO_2
   (c) anaerobic decomposition is a source for CH_4
   (d) respiration by animals and plants is a sink for O_2 and a source for CO_2
   (e) photosynthesis ($CO_2 + H_2O \rightarrow CH_2O + O_2$) is a sink for O_2 and a source for CO_2

6. Planetary atmospheres do not have a well defined top: density gets progressively smaller with increasing height z above the surface, ad infinitum. Thus it is useful to define an indicative scale for an atmosphere's depth, called the *scale height* (H). One such definition is $H = P_0/(\rho_0\, g)$, where P_0, ρ_0 are the pressure and density at the base of the atmosphere and g is gravitational acceleration on that planet. If $(P_0, \rho_0, g) = (10^5, 1, 9.81)$ for Earth (E) and $(P_0, \rho_0, g) = (700, 0.02, 3.7)$ for Mars (M), which of the following best approximates the ratio $H_\mathrm{E}/H_\mathrm{M}$ of the scale depths?

   (a) 0.01
   (b) 0.1
   (c) 1
   (d) 10
   (e) 100

7. Which layman's observation regarding Earth's air and atmosphere is most pertinent to (related to) the fact that, climatologically (i.e., on average), the temperature is warmer at the base of the troposphere than at the top of the troposphere?

   (a) air can exert a push or pull (has mass)
   (b) air is devoid of smell
   (c) air seems to be the "same stuff" no matter where one is on earth
   (d) air contains one or more substances that are essential to human life
   (e) air is invisible

8. Referring to Figure (1), what was the sea-level corrected pressure (MSLP) on the isobar that runs through the point labelled **A**?

   (a) 992 hPa
   (b) 996 hPa
   (c) 1000 hPa
   (d) 1004 hPa
   (e) 1008 hPa

9. Again referring to Figure (1), what were the conditions at the station just below **B**?

   (a) MSLP=1012.9 hPa; $T = 4^\circ$C; overcast; NW wind
   (b) MSLP=1012.9 hPa; $T = 4^\circ$C; overcast; SE wind
   (c) MSLP=912.9 hPa; $T = 4^\circ$C; overcast; NW wind
   (d) MSLP=1012.9 hPa; $T = 20^\circ$C; sunny; NW wind
   (e) MSLP=912.9 hPa; $T = 20^\circ$C; sunny; NW wind

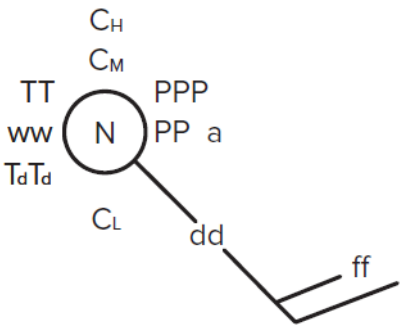
10. Referring to Figures (2,3), which statement is **false**?

    (a) over Edmonton the 850 hPa level is roughly 700 to 800 m above ground level (AGL)
    (b) the heavy dashed line is the 0°C isotherm
    (c) conditions in Central Alberta were much warmer on 10 Sept. than on 15 Sept.
    (d) on Fig. 2 a low NE of Manitoba is causing N or NW winds over N. Manitoba
    (e) on Fig. 3 a low NE of Manitoba is pulling air **south-eastward** (i.e. towards the SE) across the N. border (**B**)

Equations & Data.

- Key to Surface Weather Station data (at right).
- 1 hPa = 100 Pa, T [K] = T [°C] + 273.15
- $P = M\ g/A$

  The pressure (P, Pa) that results when mass M [kg] overlies area A [m^2], where $g = 9.81 (\approx 10)$ [m s^{-2}]



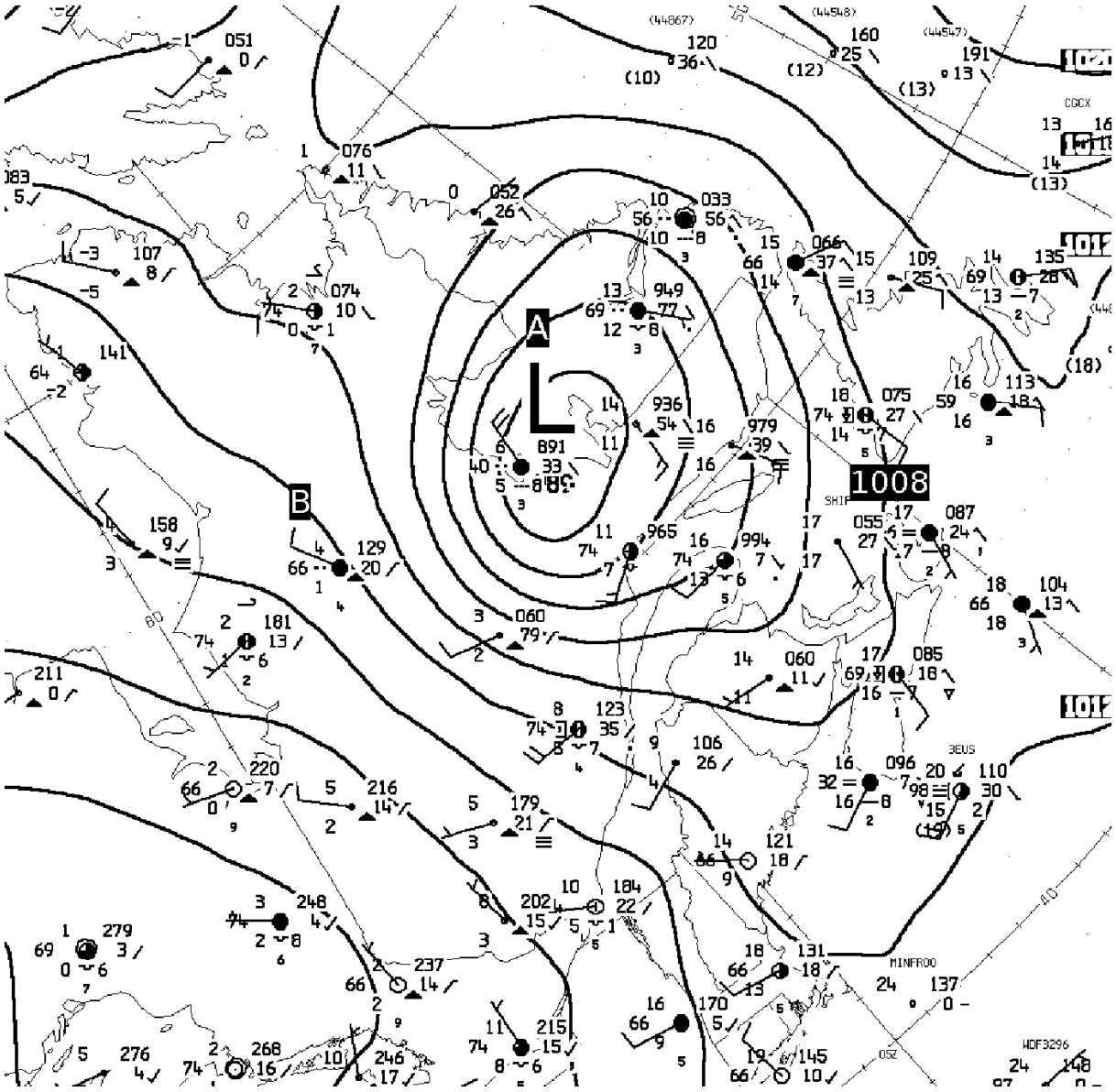


Figure 1: Environment Canada surface analysis (cropped) for 06 UTC 12 September 2014.

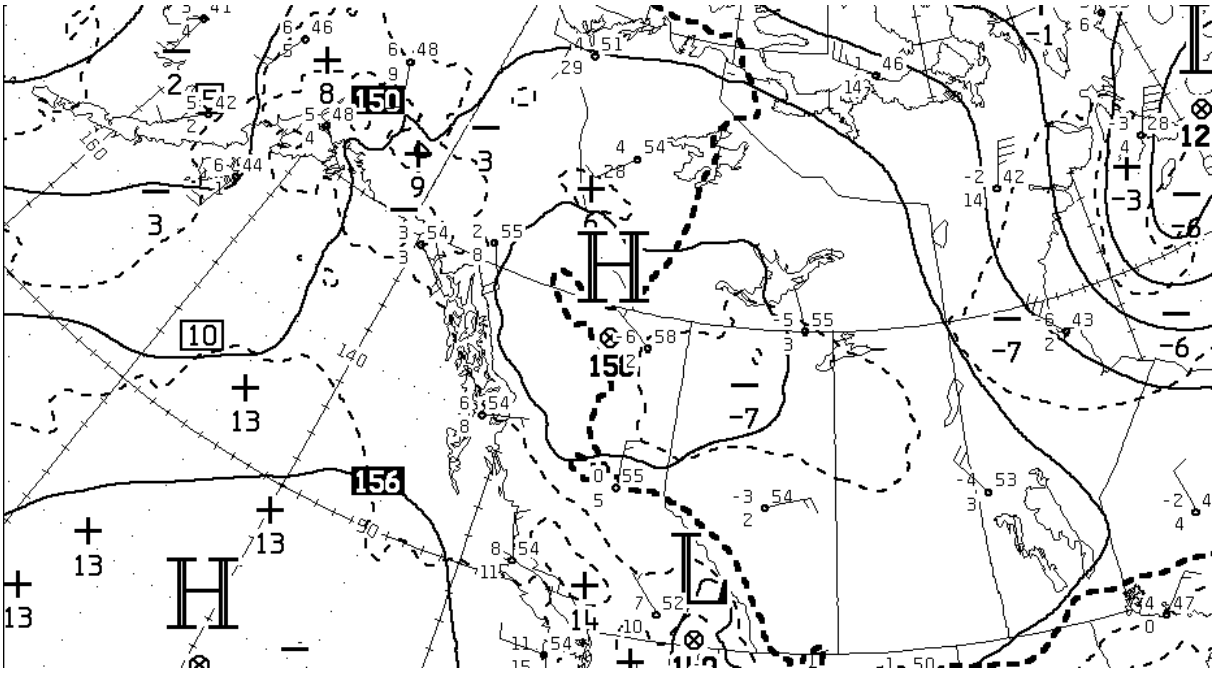


Figure 2: Environment Canada 850 hPa analysis, 00 UTC Wed. 10 Sept. 2014. Solid lines are isolines of isobaric height, labelled in decameters (dam), where 1 dam = 10 m.

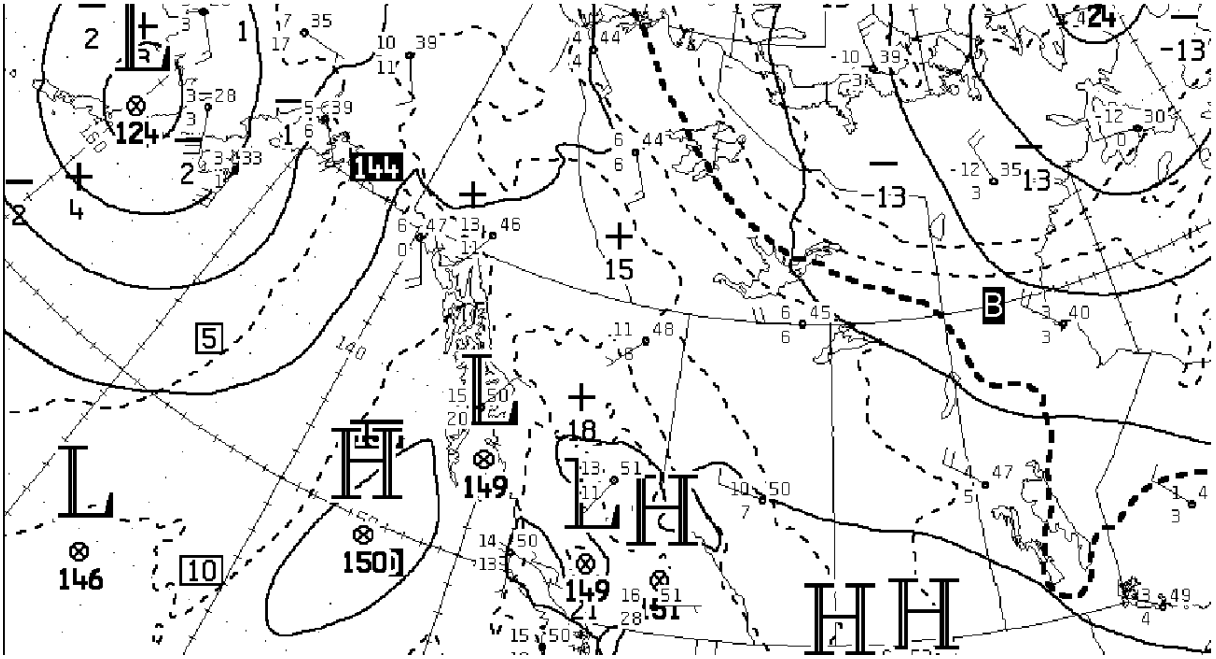


Figure 3: Environment Canada 850 hPa analysis, 00 UTC Mon. 15 Sept. 2014.