EAS270, "The Atmosphere" Quiz 1 21 Sept., 2009

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

Instructions: For all 10 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. The troposphere, which extends from the base of the atmosphere to a height of about ____ , is characterized by a steady ____ of climatological mean temperature with increasing height
   (a) 80 kilometers; increase
   (b) 50 kilometers; increase
   (c) 10 kilometers; increase
   (d) 50 kilometers; decrease
   (e) 10 kilometers; decrease ✓✓

2. The two most abundant permanent gases in earth's homosphere are ____ ; and together they account for ____ % of the air by volume
   (a) N_2, O_2; 79%
   (b) N_2, O_2; 99% ✓✓
   (c) N_2, Ar ; 79%
   (d) O_2, Ar ; 99%
   (e) N_2, H_2O; 63%

3. Density of the atmosphere ____
   (a) increases with increasing height
   (b) does not change with height within the homosphere (lowest 80 km)
   (c) decreases with increasing height ✓✓
   (d) has the MKS unit kg m^{-1} ("kilograms per metre")
   (e) has the MKS unit Pa ("Pascals")

4. About ____ % of atmospheric mass lies above the 700 hPa level
   (a) 99
   (b) 70 ✓✓
   (c) 50
   (d) 30
   (e) 1

5. The gas released to the atmosphere by volcanoes ("outgassing") is mostly composed of ____

   (a) nitrogen and oxygen
   (b) nitrogen and water vapour
   (c) carbon dioxide and nitrogen
   (d) water vapour and carbon dioxide ✓✓
   (e) methane and ozone

6. Solar elevation above the horizon in Edmonton (latitude 53.5 degrees N), at solar noon on the day of the winter solstice, is ____ degrees

   (a) 13 ✓✓
   (b) 23.5
   (c) 45
   (d) 60
   (e) 75

7. If earth's average surface temperature were to increase, the rate of emission of radiation energy from its surface would ____ and the wavelength (λ_{max}) of the peak in the emission spectrum would shift towards ____ wavelengths

   (a) increase, shorter ✓✓
   (b) increase, longer
   (c) decrease, longer
   (d) decrease, shorter
   (e) increase, redder

8. The numerical value of earth's "solar constant" is about ____

   (a) 9.8 [m s^{-2}]
   (b) 0.5 [μm]
   (c) 4 [μm]
   (d) 500 [W m^2]
   (e) 1370 [W m^{-2}] ✓✓

For the remaining questions, please refer to the attached surface analysis.

9. The pressure change at the Alberta station farthest to the northwest (and reporting $T = 6^{o}C$, $T_d = 3^{o}C$) was ____

   (a) a rise of 19 hPa
   (b) a rise of 1.9 hPa ✓✓
   (c) no change
   (d) 74 hPa
   (e) 7.4 hPa

10. Sea-level corrected pressure at the location marked by the large cross (**X**, just north of the northern border of British Columbia) was about ____ hPa

    (a) 10.14
    (b) 1004
    (c) 1014 ✓✓
    (d) 1020
    (e) 1027

Equations and Data.

- $p = \frac{M\,g}{A}$

  The pressure p [Pa] that results when a mass M [kg] of air overlies area A [m^2], where $g \approx 10$ [m s^{-2}] is the acceleration due to gravity

- 1 hPa = 100 Pa

  Pressure unit conversion. Sea-level pressure on earth is roughly 1000 hPa.

- $L \uparrow = \epsilon\,\sigma\,T^4$

  Stefan-Boltzmann law. $L \uparrow$ [W m^{-2}], the emitted longwave energy flux density (for which our textbook uses the symbol "I"); ϵ, the emissivity of the surface (dimensionless); $\sigma = 5.67 \times 10^{-8}$ [W m^{-2} K^{-4}], the Stefan-Boltzmann constant; T [K], the surface temperature.

- $\lambda_{max} = \frac{2900}{T}$

  Wien's displacement law. λ_{max} [μm], the wavelength at which the peak in the emission spectrum occurs; T [K], the temperature of the emitting surface.

- $\theta = 90 - \Phi_{lat} + \phi_{sol.dec}$

  The solar elevation θ at solar noon, at a location with latitude Φ_{lat}, at the time of year when solar declination is $\phi_{sol.dec}$. Latitude is negative in the southern hemisphere; and solar declination is negative during northern hemisphere winter.

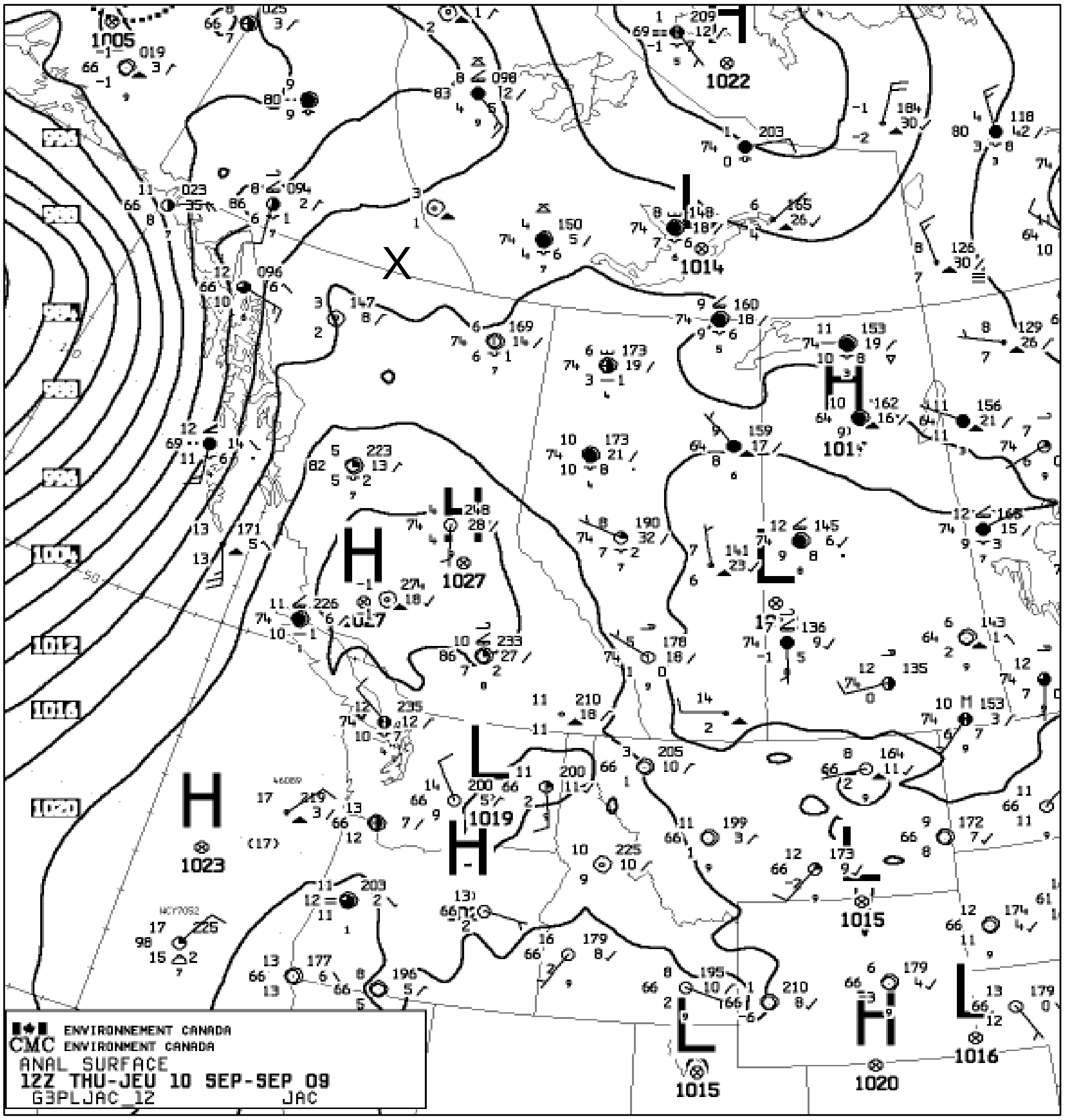

Figure 1: CMC surface analysis, 12Z Sept. 10, 2009