EAS270, "The Atmosphere" Quiz 1 24 Sept., 2010

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. Order-of-magnitude values for air density (ρ) and pressure p at sea-level are ____
   (a) $1000\,\mathrm{kg\ m^{-3}}$; 1000 Pa
   (b) $1\,\mathrm{kg\ m^{-3}}$; 1000 Pa
   (c) $1\,\mathrm{kg\ m^{-3}}$; 1000 hPa ✓✓
   (d) 1 kPa; $1\,\mathrm{kg\ m^{-2}}$
   (e) $0.1\,\mathrm{kg\ m^{-3}}$; 100 kPa

2. The approximate percentages by volume of nitrogen (N_2), oxygen (O_2), and 'all other gases (AOG)' in the troposphere are N_2, O_2, AOG = ____ %
   (a) 10, 20, 70
   (b) 33.3, 33.3, 33.3
   (c) 50, 40, 10
   (d) 70, 20, 10
   (e) 78, 21, 1 ✓✓

3. Present day CO_2 concentration is about ____
   (a) 390 $\mathrm{kg\ m^{-3}}$
   (b) 1370 $\mathrm{kg\ m^{-3}}$
   (c) 0.039 $\mathrm{kg\ m^{-3}}$
   (d) 390 ppmv (parts per million by volume) ✓✓
   (e) 1370 ppmv (parts per million by volume)

4. Despite the fact that it makes up about ____ % by volume of the atmosphere, nitrogen gas N_2 has "relatively little effect on most meteorological processes" because ____
   (a) 21; it is not a greenhouse gas
   (b) 21; it is a "permanent" gas with a very long residence time
   (c) 78; it is a "variable" gas with a very short residence time
   (d) 78; it is a "permanent" gas with a very long residence time, and does not interact with terrestrial radiation ✓✓
   (e) 98; it is not a greenhouse gas

5. The "shortwave" (or "solar") radiation band spans approximately ____ [μm]

   (a) 0.4 – 40
   (b) 0.4 – 4 ✓✓
   (c) 4 – 100
   (d) 40 – 100
   (e) 0.4 – 100

6. In atmospheric science the "solar constant" refers to ____

   (a) the strength of the solar beam (1370 W m^{-2}) measured above earth's atmosphere ✓✓
   (b) the outgoing terrestrial radiant energy flux density (1370 W m^{-2}) measured above the atmosphere
   (c) the inclination (23.5 degrees) of earth's spin axis relative to the plane of its orbit
   (d) the radius (about 150 million km) of earth's orbit about the sun
   (e) the rate of radiant energy release by the sun [J s^{-1}]

7. The emission spectrum of a certain black body has its spectral peak at wavelength $\lambda_{\max} = 14\,\mu$m. The temperature of the body must be about ____

   (a) 207°C
   (b) 67°C
   (c) 207K ✓✓
   (d) −67K
   (e) 480K

8. Suppose two (otherwise identical) graybody surfaces are at temperatures T, $2T$ [K]. The hotter surface radiates energy at a rate that is ____ times the rate of the cooler surface

   (a) 1/2
   (b) 2
   (c) 1/4
   (d) 4
   (e) 16 ✓✓

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

9. In the northern hemisphere winds blow ____ about a low pressure system. At the Churchill station reported wind speed was about ____ and the wind was blowing ____ the north-northwest (NNW)

   (a) clockwise; 15 $\mathrm{m\,s^{-1}}$; to

   (b) anticlockwise; 15 $\mathrm{m\,s^{-1}}$; to

   (c) clockwise; 7.5 $\mathrm{m\,s^{-1}}$; from

   (d) anticlockwise; 15 $\mathrm{m\,s^{-1}}$; from ✓✓

   (e) anticlockwise; 7.5 $\mathrm{m\,s^{-1}}$; from

10. Wind direction (in the reporting convention used in meteorology) and sea-level corrected pressure at Churchill were ____

    (a) NNW; 1010.7 hPa ✓✓

    (b) NNW; 910.7 hPa

    (c) NNW; 1070 hPa

    (d) SSE; 910.7 hPa

    (e) NNW; 910.7 hPa

Equations and Data.

- one full barb on the wind vector corresponds to about 5 $\mathrm{m\ s^{-1}}$

- 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

- $L_{\uparrow} \; = \; \epsilon \, \sigma \, T^4$

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

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

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

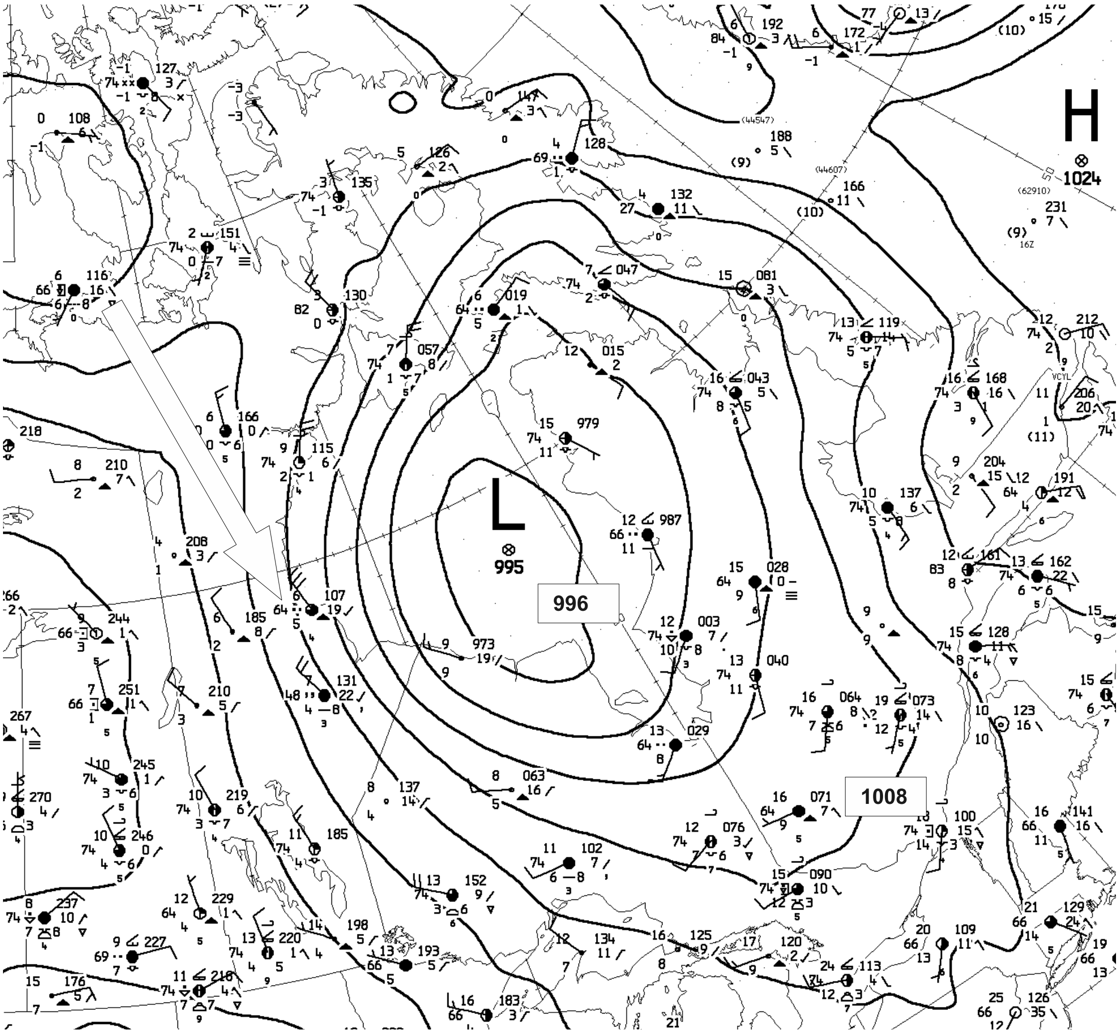

Figure 1: CMC surface analysis, 18Z Sept. 13, 2010. The white arrow points towards the station at Churchill, Manitoba, on the west flank of the low pressure system. The latitude lines (running W-E) and longitude lines (running S-N) provide a frame of reference for the orientation of the station wind vector.