EAS372 Mid-term Exam 2 Feb., 2010

Professor: J.D. Wilson Time available: 80 mins Value: 15%

Please answer in the booklet provided. Equations and data given at back.

A. "Live" web weather data (8 x 1/2 → 4%)

1. Height (ASL) of the 500 hPa surface over Edmonton at 12Z this morning was ____ *535 dam, from 500 hPa chart; 5350 m off the sounding data*

2. 1000-500 hPa thickness at Edmonton at 12Z this morning was ____ *About 522* dam, *by interpolating between thickness contours on the 500* hPa *chart;* $5350 - 116 = 5234$ m *off the sounding data*

3. According to the GEM Regional Model run initialized at 12Z today, the 1000-500 hPa thickness over Edmonton at 12Z Wed 3 Feb. will be ____ *about 522* dam

4. According to this morning's Edmonton sounding, true surface pressure was ____ 922 hPa

5. According to this morning's Edmonton sounding, height (AGL) of the 500 hPa surface over Edmonton was ____ $5350 - 766 = 4584$ m

6. According to this morning's conditions at Edmonton, if a parcel of air from the 700 hPa level were to descend adiabatically to the 925 hPa level, its temperature would be ____ *About* $+5^{o}$ *— obtained by following a dry adiabat down through* (700 hPa, -15.1) *down to 925* dam

7. Use Vizaweb to access the 0h panel of the GEM Regional Run initialized at 12Z today; choose N_America as Domain. The strongest updraft at the 850 hPa level has a magnitude in the range ____ Pa/s -4 *to* -8 Pa/s

8. According to the NAM model run initialized at 06UTC today, the central (sea-level corrected) pressure of the deepest low in the forecast domain (at 12Z today) is ____ (952 hPa *At centre of the low off the east coast — a bit tricky — one had to count down the isobars in 4* hPa *steps; I also accepted 956* hPa

B. Interpretation of weather situation. (6 x 1/2 → 3%)

Figures (1 - 4) relate to weather in Western Canada on 11^{th} & 25^{th} Jan., 2010.

1. Fort Nelson (in North-east B.C.) was experiencing strong ____ low-level temperature advection on ____

   (a) warm; 11 Jan. ✓✓(*based on configuration of 850 hPa height contours and isotherms*)

   (b) cold; 11 Jan.

   (c) warm; 25 Jan.

   (d) cold; 25 Jan.

2. Alberta was under the influence of ____ on ____

   (a) lee trough; 11 Jan. ✓✓
   (b) lee trough; 25 Jan.
   (c) strong northerly wind aloft; 11 Jan.
   (d) strong northerly wind aloft; 25 Jan.

3. Which of the following meteorological features is *not* common to both days?

   (a) Upper ridge axis running through Alberta
   (b) Well formed low on the B.C. coast
   (c) Coastal southerlies or SS-westerlies at 850 hPa in Washington State
   (d) Front spanning northern B.C. and northern Alberta ✓✓

4. From the given information, Edmonton would be more likely to have received precipitation on ____ whereas Fort Nelson would more likely have received precipitation on ____

   (a) 11 Jan; 25 Jan
   (b) 25 Jan; 11 Jan ✓✓

5. At 00Z on 11 Jan., Fort Smith (N.W.T. near NE corner of Alberta) likely would have been undergoing ____

   (a) clearing skies and rapid advective warming
   (b) clearing skies and rapid advective cooling
   (c) strong surface winds
   (d) cloudy conditions with rather steady temperature ✓✓(*weak low-level winds; low T-Td spreads*)

6. Judging by the 850 hPa charts, at 00Z on 11 Jan. the SE coast of the U.S. was experiencing ____ while at 00Z on 25 Jan. the same zone was experiencing ____

   (a) subzero northwesterlies; warm southerlies ✓✓
   (b) warm northwesterlies; cold southerlies

C. Calculations (4 x 2 → 8 %)

1. Referred to $p_0 = 10^5$ Pa the potential temperature of air with $(p, T) = (7 \times 10^4\,\text{Pa}, -15^\circ\text{C})$ is $\theta =$ ____ K.

   - $\theta = (273.16 - 15)\,(10/7)^{0.287} \approx 286$ K

2. Referring to Fig. (5), compute the Geostrophic 500 hPa windspeed at Fort Smith (YSM, the station just north of the NE corner of Alberta) and compare with the reported speed.

- $V \approx 13 \pm 2$ m s^{-1}
- reported speed about 17.5 m s^{-1}
- $f \approx 1.3 \times 10^{-4}$ s^{-1}

3. Referring to today's Edmonton sounding, from the temperature and dewpoint at 850 hPa compute the vapour pressure e and absolute humidity ρ_v (use the equilibrium vapour pressure table that is accessible on the course web site).

   - temperature and dewpoint were equal, at -6.5°C. Thus the vapour pressure $e = e_*(T_d) = 353$ Pa.
   - $\rho_v = 2.9 \times 10^{-3}$ kg m^{-3}

4. Referring to Fig. (6), compute the rate of temperature advection A_T at The Pas (Le Pas) in west-central Manitoba and give your answer in °C hr^{-1}. State whether this corresponds to warming or cooling.

   - speed is about 10 m s^{-1}
   - $\Delta T/\Delta s \approx -4 \times 10^{-5}$ K m^{-1}
   - $\Delta T/\Delta t \approx 1.5$ °C hr^{-1}, warming

Equations and Data.

- one full barb on the wind vector corresponds to 5 m s^{-1}, and 1 degree of latitude corresponds to a distance of 111 km

- $e = \rho_v \, R_v \, T$, the ideal gas law for water vapour. e [Pascals], vapour pressure; ρ_v, [kg m^{-3}] the absolute density; T [Kelvin], the temperature; and $R_v = 462$ [J kg^{-1} K^{-1}], the specific gas constant for water vapour.

- $\theta = T \left(\frac{p_0}{p}\right)^{R/c_p}$, the potential temperature θ [K] of air whose actual pressure and temperature are (p, T), ie. the temperature that air would have if compressed adiabatically to pressure p_0. The exponent involves the gas constant for air ($R = 287$ J kg^{-1} K^{-1}) and the specific heat of air at constant pressure ($c_p \approx 1000$ J kg^{-1} K^{-1}). Temperatures must be expressed in the Kelvin unit.

- $\left(\frac{\partial T}{\partial t}\right)_{adv} = -V \, \frac{\partial T}{\partial s}$

  Advective contribution to the rate of change of temperature, expressed in natural coordinates. The unit vector $\hat{s}$ for the s axis points downstream and parallel to the flow contours (eg. height contours), and V is the wind *speed*.

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

  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 Ω is the angular velocity of the earth, and ϕ is latitude); g acceleration due to gravity.

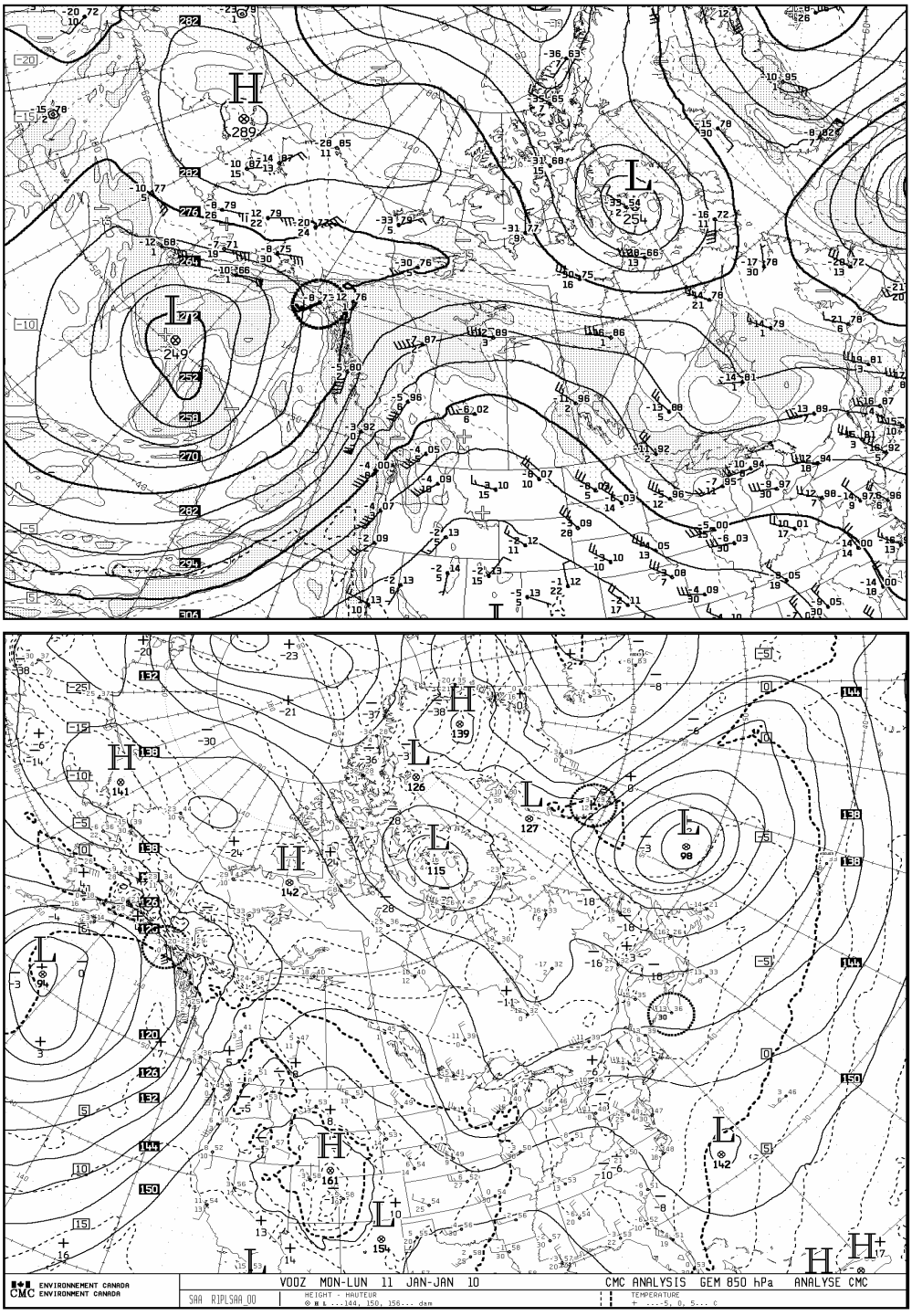

Figure 1: 00Z CMC 700 mb & 850 hPa analyses for 11 Jan., 2010.

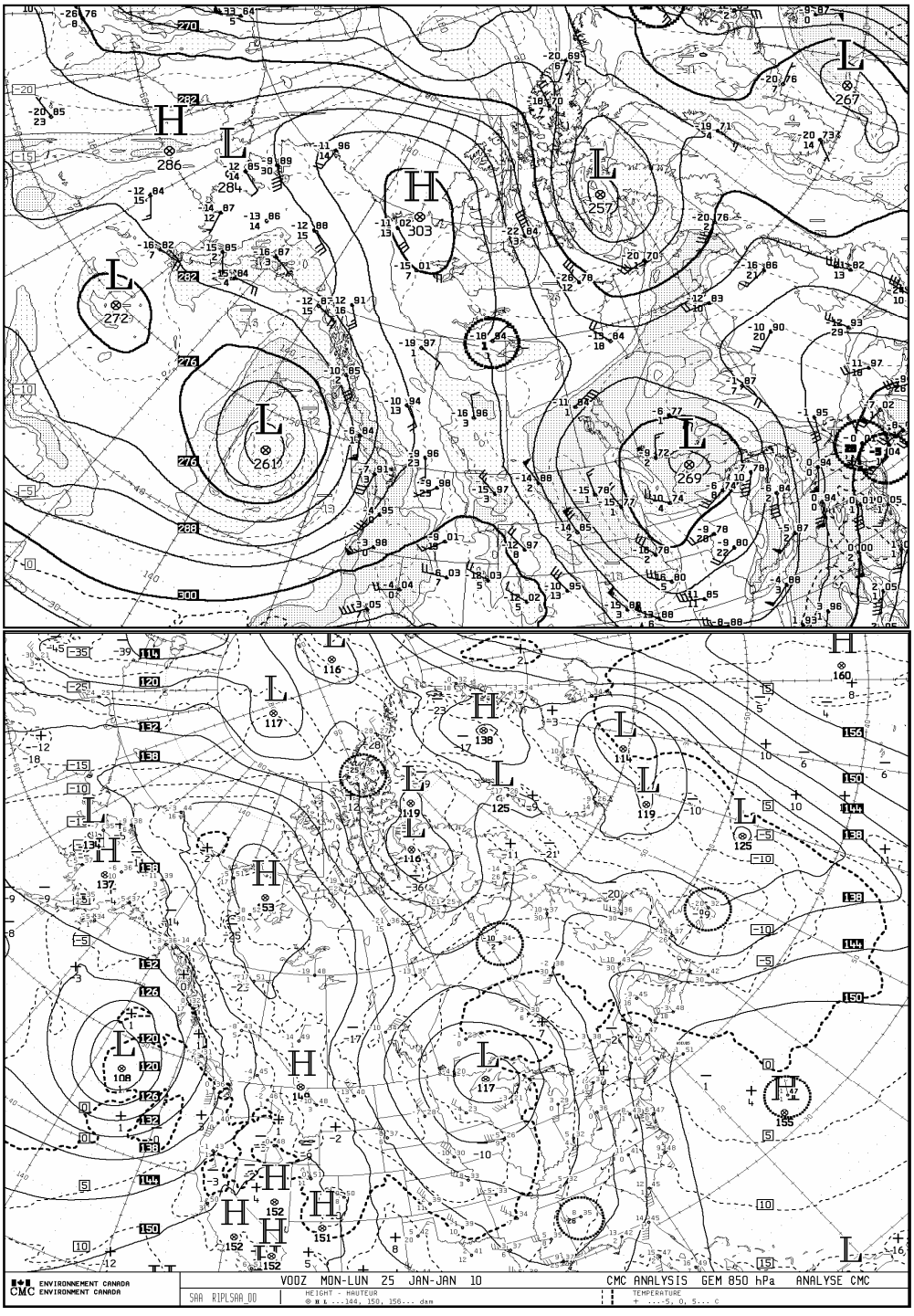

Figure 2: 00Z CMC 700 mb & 850 hPa analyses for 25 Jan., 2010.

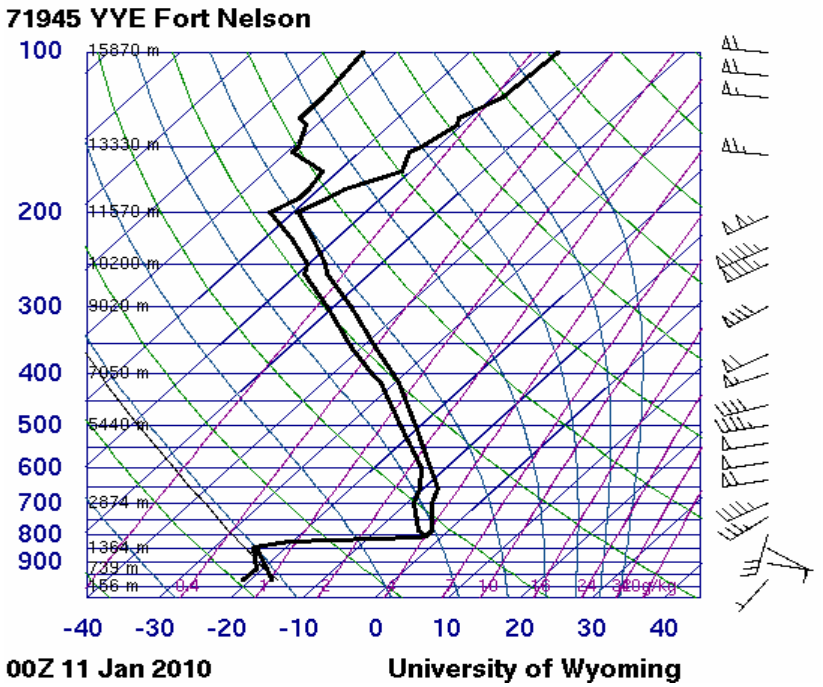

Figure 3: Sounding at Fort Nelson (NW corner of B.C.) at 00Z on 11 Jan., 2010.

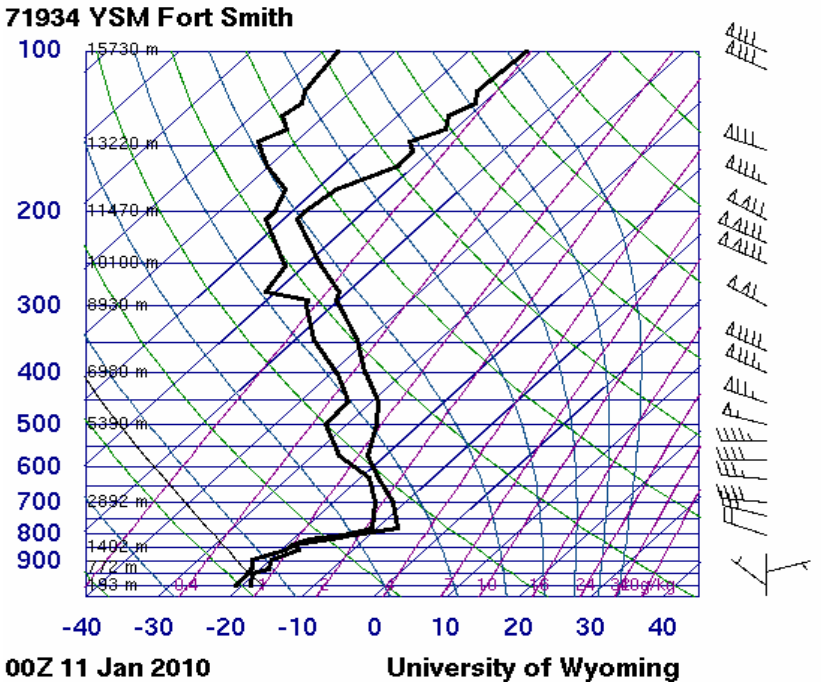

Figure 4: Sounding at Fort Smith in N.W.T. (near NE corner of Alberta) at 00Z on 11 Jan., 2010.

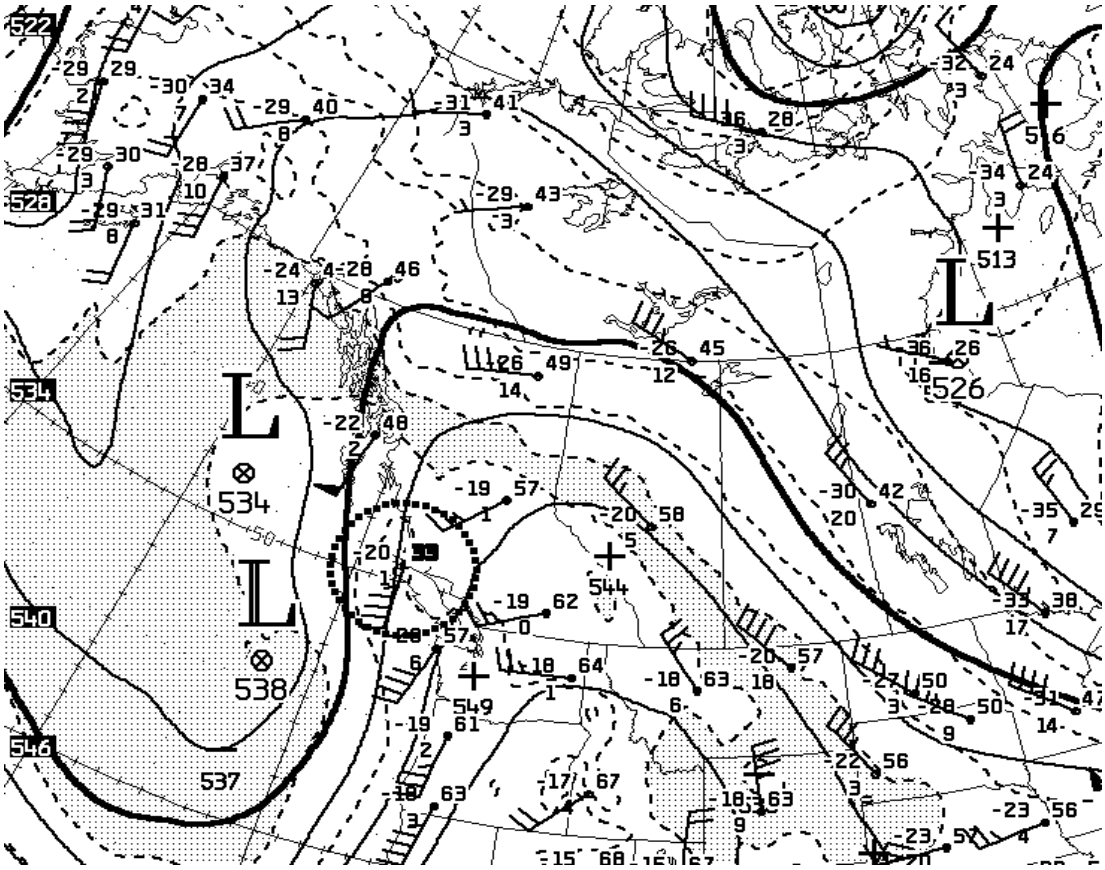

Figure 5: CMC 500 mb Analysis for 12Z 29 Jan., 2010.

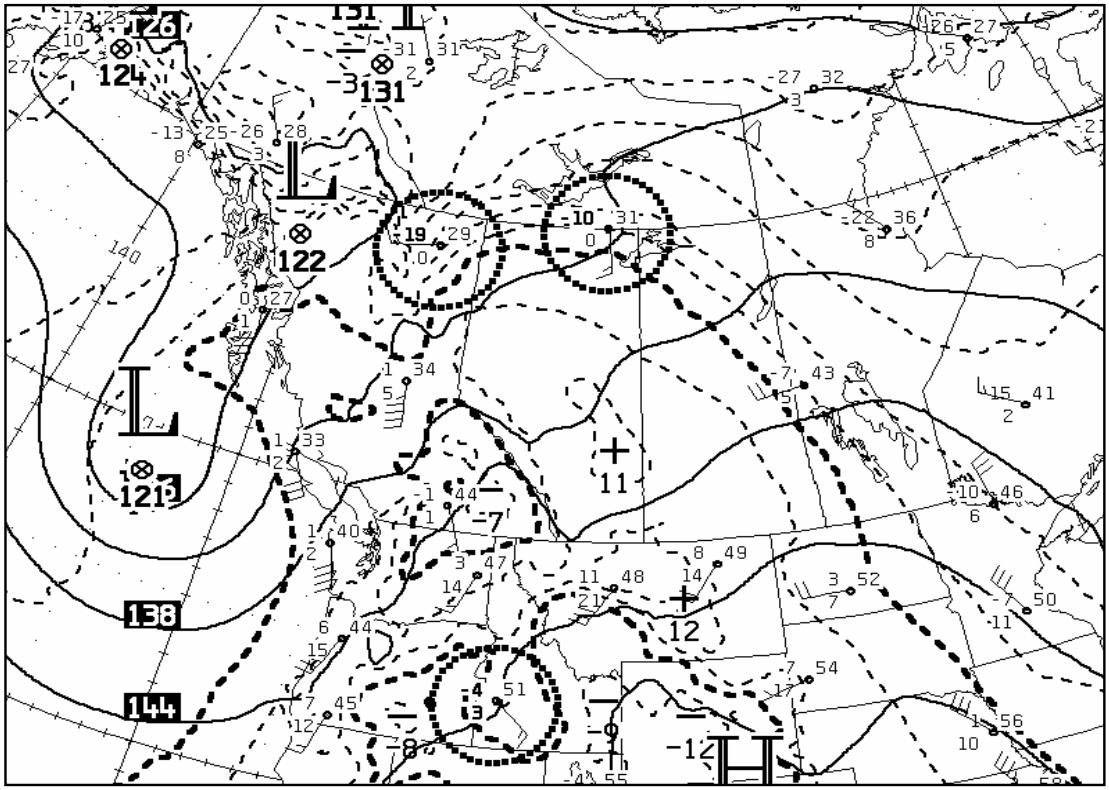

Figure 6: CMC 850 mb analysis for 12Z on 25 Jan. 2006.

Class structure, environment, delivery

– your (anonymous) feedback will be appreciated