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 ____
2. 1000-500 hPa thickness at Edmonton at 12Z this morning was ____
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 ____
4. According to this morning's Edmonton sounding, true surface pressure was ____
5. According to this morning's Edmonton sounding, height (AGL) of the 500 hPa surface over Edmonton was ____
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 ____
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
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 ____

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.
   (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

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 $\rightarrow$ 8 %)

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

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).

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 $^{\circ}\mathrm{C\,hr^{-1}}$. State whether this corresponds to warming or cooling.

Equations and Data.

- one full barb on the wind vector corresponds to 5 m $\mathrm{s^{-1}}$, 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 $\mathrm{m^{-3}}$] the absolute density; T [Kelvin], the temperature; and $R_v = 462$ [J $\mathrm{kg^{-1}}$ $\mathrm{K^{-1}}$], 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 $\mathrm{kg^{-1}}$ $\mathrm{K^{-1}}$) and the specific heat of air at constant pressure ($c_p \approx 1000$ J $\mathrm{kg^{-1}}$ $\mathrm{K^{-1}}$). 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; $f = 2\Omega \, \sin\phi$ [$\mathrm{s^{-1}}$] the Coriolis parameter (where Ω is the angular velocity of the earth, and ϕ is latitude); g acceleration due to gravity.

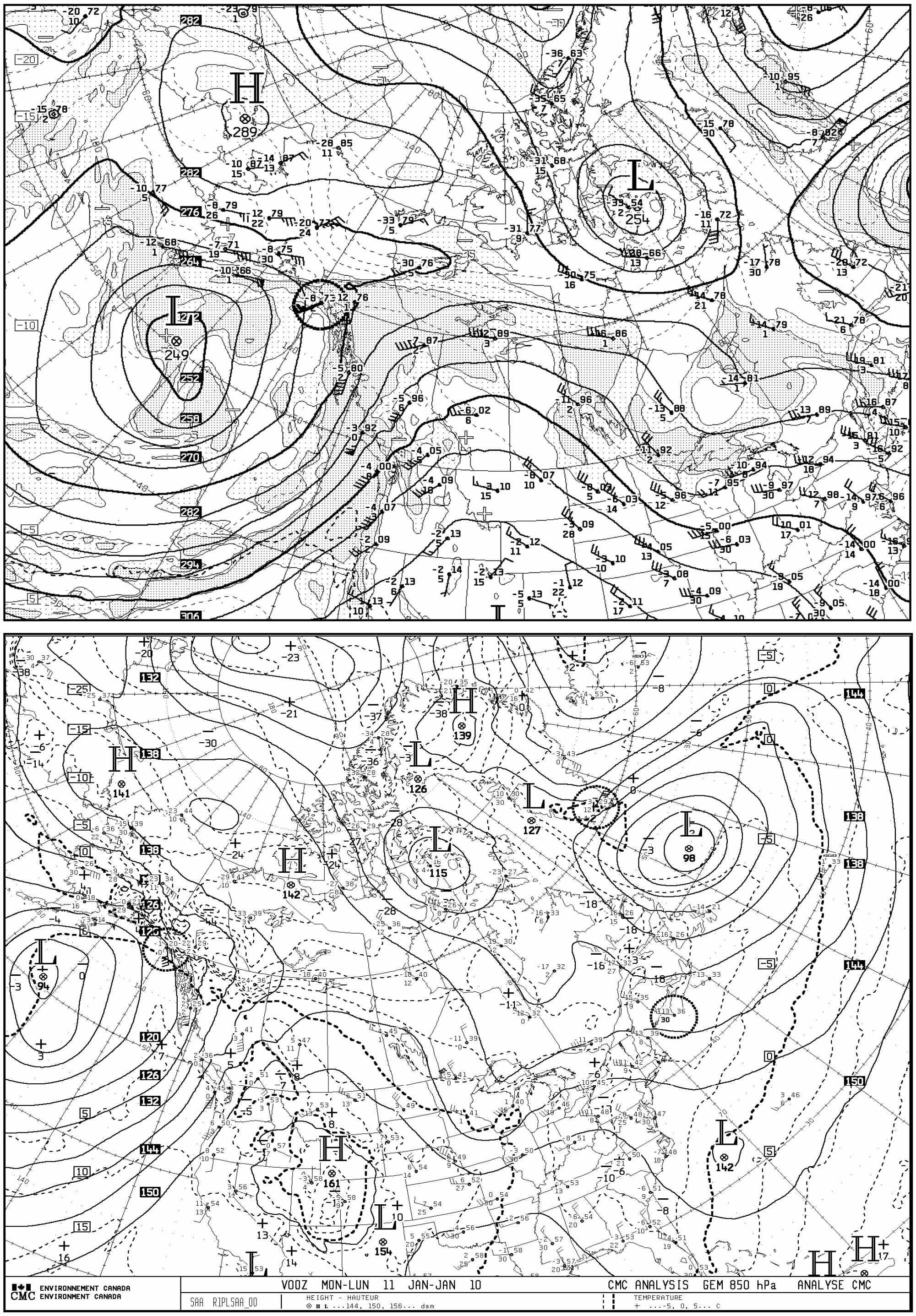

Figure 1: 00Z CMC 700 mb & 850 hPa analyses for 11 Jan., 2010.

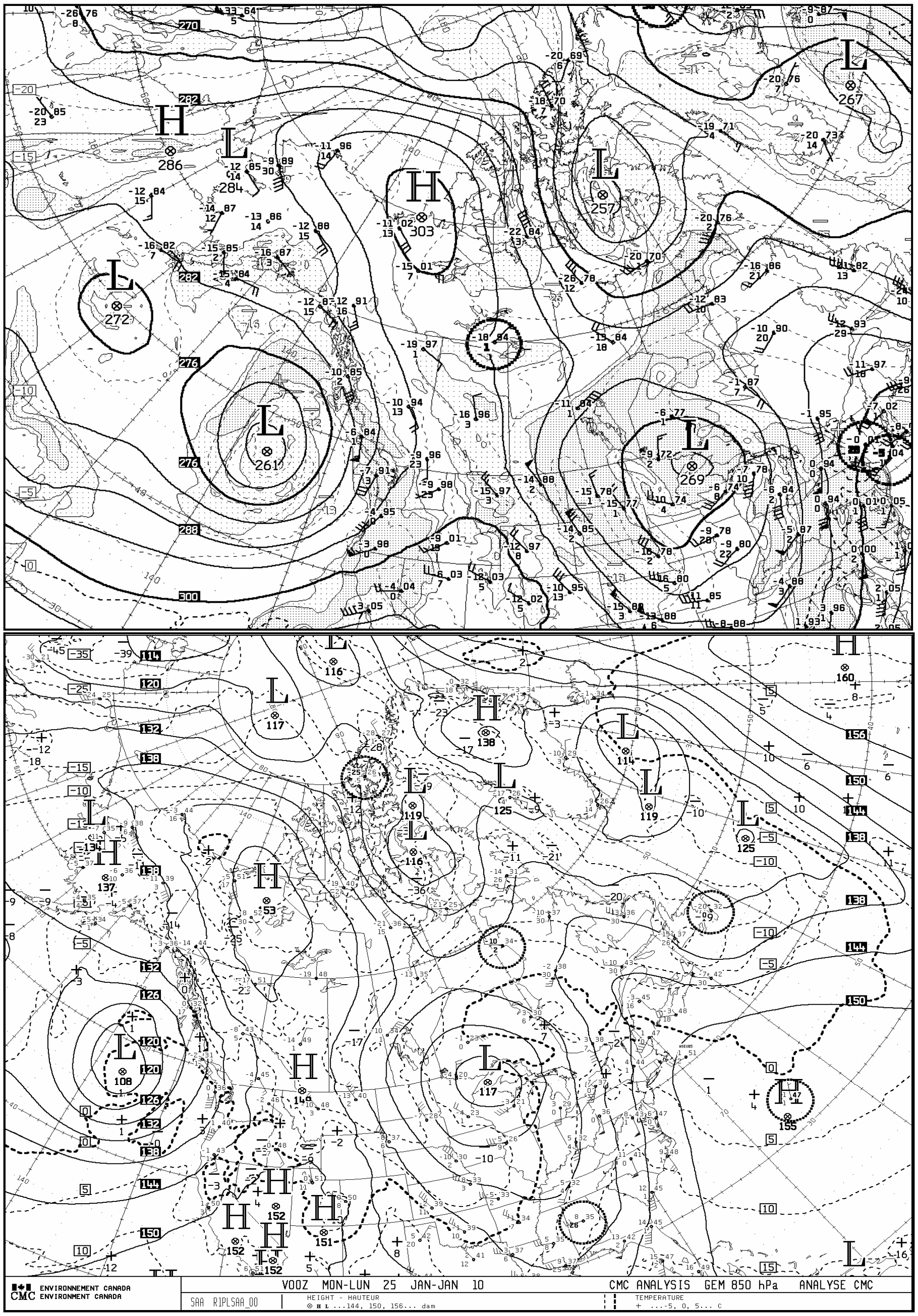

Figure 2: 00Z CMC 700 mb & 850 hPa analyses for 25 Jan., 2010.

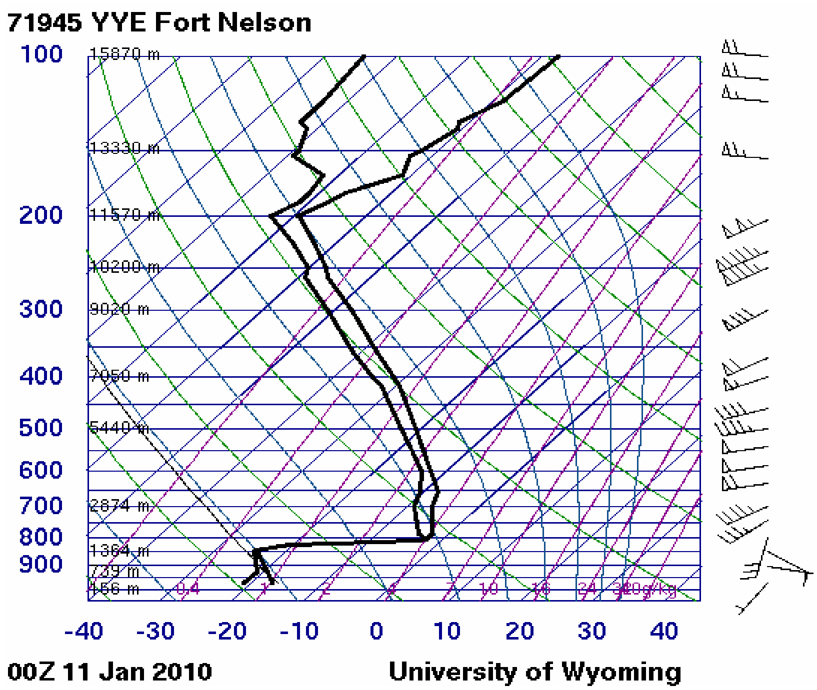

Figure 3: Sounding at Fort Nelson (NW corner of B.C.) at 00Z on 11 Jan., 2010.

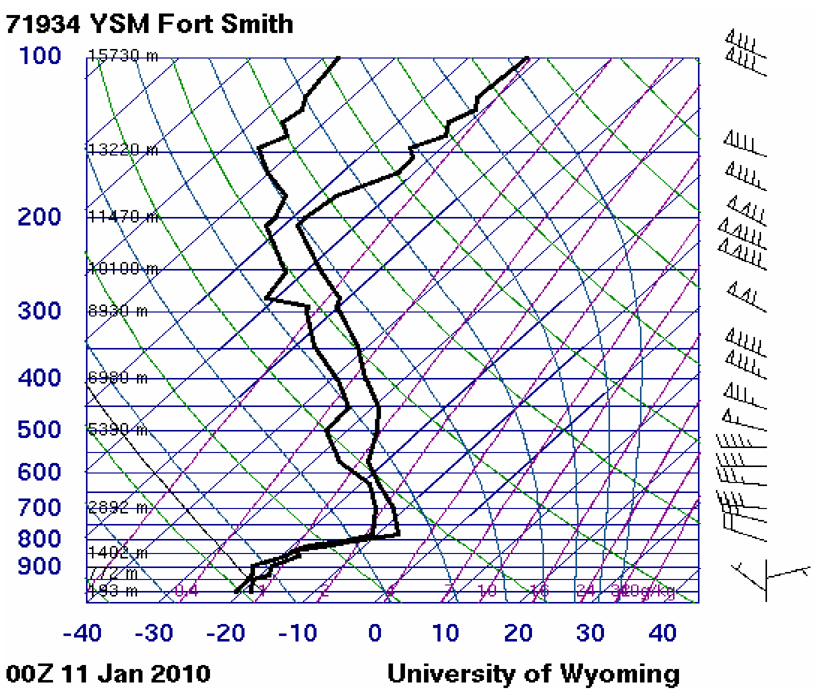

Figure 4: Sounding at Fort Smith in N.W.T. (near NE corner of Alberta) at 00Z on 11 Jan., 2010.

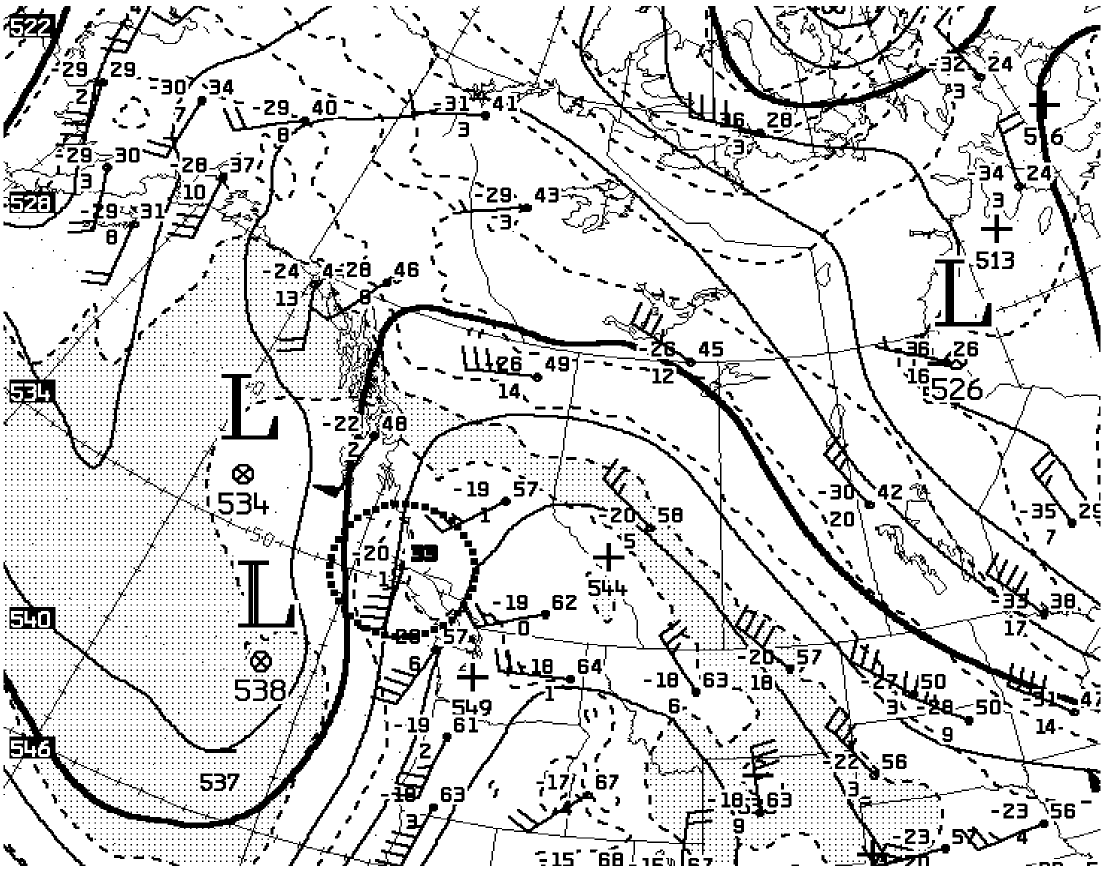

Figure 5: CMC 500 mb Analysis for 12Z 29 Jan., 2010.

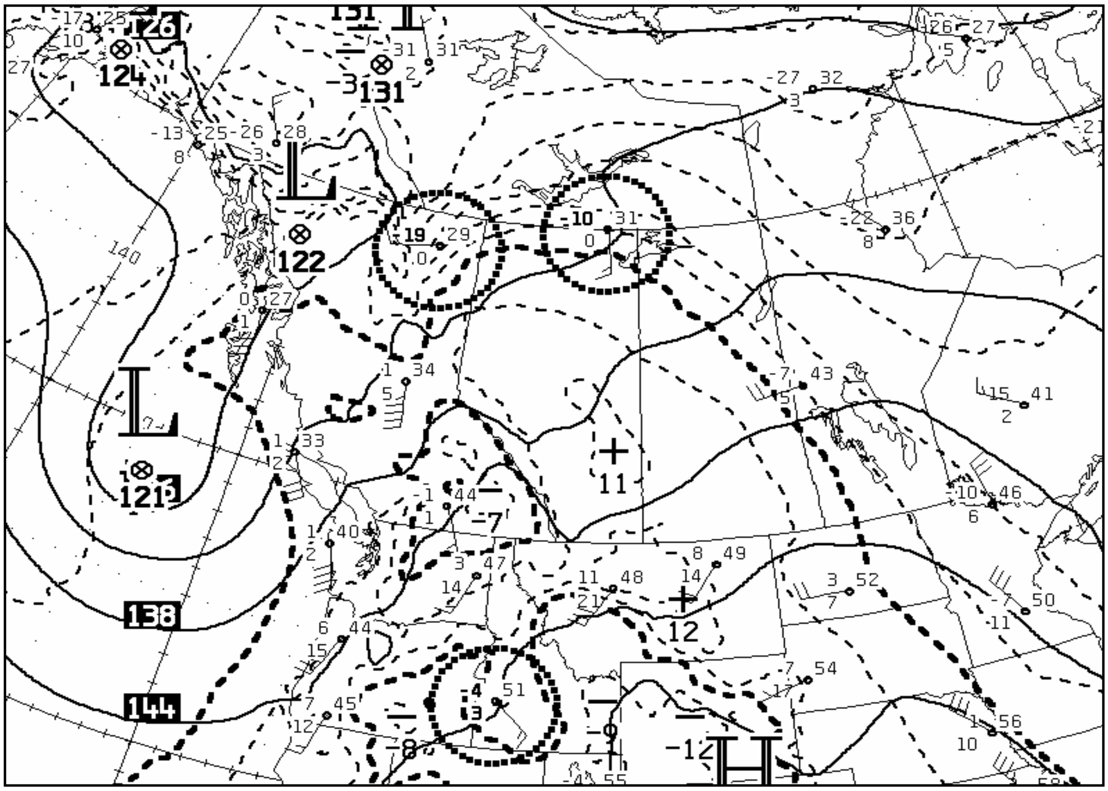

Figure 6: CMC 850 mb analysis for 12Z on 25 Jan. 2006.

Class structure, environment, delivery

– your (anonymous) feedback will be appreciated