EAS372 Mid-term Exam 9 Mar., 2010

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

Please answer in the booklet provided; please attach your hodograph, and any other figure(s) that illustrate your working. Equations and data given at back.

A. "Live" web weather data (10 x 1/2 → 5%)

1. 1000-500 hPa thickness at Edmonton at 12Z this morning was ____
2. As of 12Z today, the maximum analyzed depth of precipitable water anywhere over Alberta or Saskatchewan was in the range of about ____
3. According to the GEM Regional Model run initialized at 12Z today, the 1000-500 hPa thickness over Edmonton at 12Z Wed 10 Mar. will be about ____
4. According to the GEM Regional Model run initialized at 12Z today, the maximum 12 hour accumulated precipitation anywhere in Alberta or Saskatchewan should be in the range of about ____
5. According to this morning's Edmonton sounding, true surface pressure 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 ____
9. According to the most recent METAR for CYEG (Edmonton International Airport), surface windspeed and direction were ____
10. Present weather conditions at Lloydminster are ____ (please note the time for which your answer applies)

B. Interpretation of weather situation. (2 x 2 → 4%)

1. Referring to Figures (1, 2), briefly summarize the meteorological situation over the Canadian prairies at 12Z on Saturday 7 March 2010.
2. Plot the sounding data for Churchill (Table 1, below) onto the blank hodograph, and indicate the thermal wind vectors connecting each pair of levels. Interpret your finding relative to Figures (1, 2).

Table 1: Abbreviated YYQ sounding (Churchill, Manitoba) for 12Z Saturday 7 March 2010: giving pressure, height, temperature, wind direction and speed (knots) at mandatory levels.

p	z	T	β	v
850	1369	-7.9	335	20
700	2877	-6.5	315	41
500	5420	-23.9	320	57
250	10110	-59.9	330	87

C. Calculations (3 x 2 → 6 %)

For the following calculations please refer to Figure (4). Note that your computations will be *approximate*, i.e. *unique* and *exact* answers do not exist. Please record any assumption(s) you make in your working.

1. Estimate the Geostrophic wind speed at (latitude, longitude)=$(40^o, 147^o)$.
2. Estimate the stretching contribution $\partial v/\partial s$ to the horizontal divergence D_p along the 294 dam height contour at (latitude, longitude)=$(40^o, 147^o)$.
3. In the same region of the map, i.e. latitude and longitude of roughly $(40^o, 147^o)$, estimate the diffluence contribution $v\ \partial\beta/\partial n$ to the horizontal divergence D_p. Treat the nearby 300 and 288 dam height contours as the basis for the calculation.

Equations and Data.

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

- $\theta = T \left(\frac{p_0}{p}\right)^{R/c_p}$, 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.

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

  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.

- $D_p \equiv \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}$

  The horizontal divergence, expressed in Cartesian coordinates (x parallel to lines of latitude, increasing towards the east; y parallel to lines of longitude).

- $D_p \equiv \frac{\partial v}{\partial s} + v \frac{\partial \beta}{\partial n}$

  The horizontal divergence, expressed in natural coordinates. The unit vector $\hat{s}$ points downstream, i.e. it is parallel to height contours in the free atmosphere. The unit vector $\hat{n}$ is normal to $\hat{s}$ and points to its left. The angle β is the inclination of flow relative to lines of latitude, with $\beta = 0^{\circ}$ being a zonal flow and $\beta = 90^{\circ}$ being a meridional flow. The first term is the stretching term. The second term is the diffluence term, and is positive if the channel widens downstream (ie. widens with increasing s).

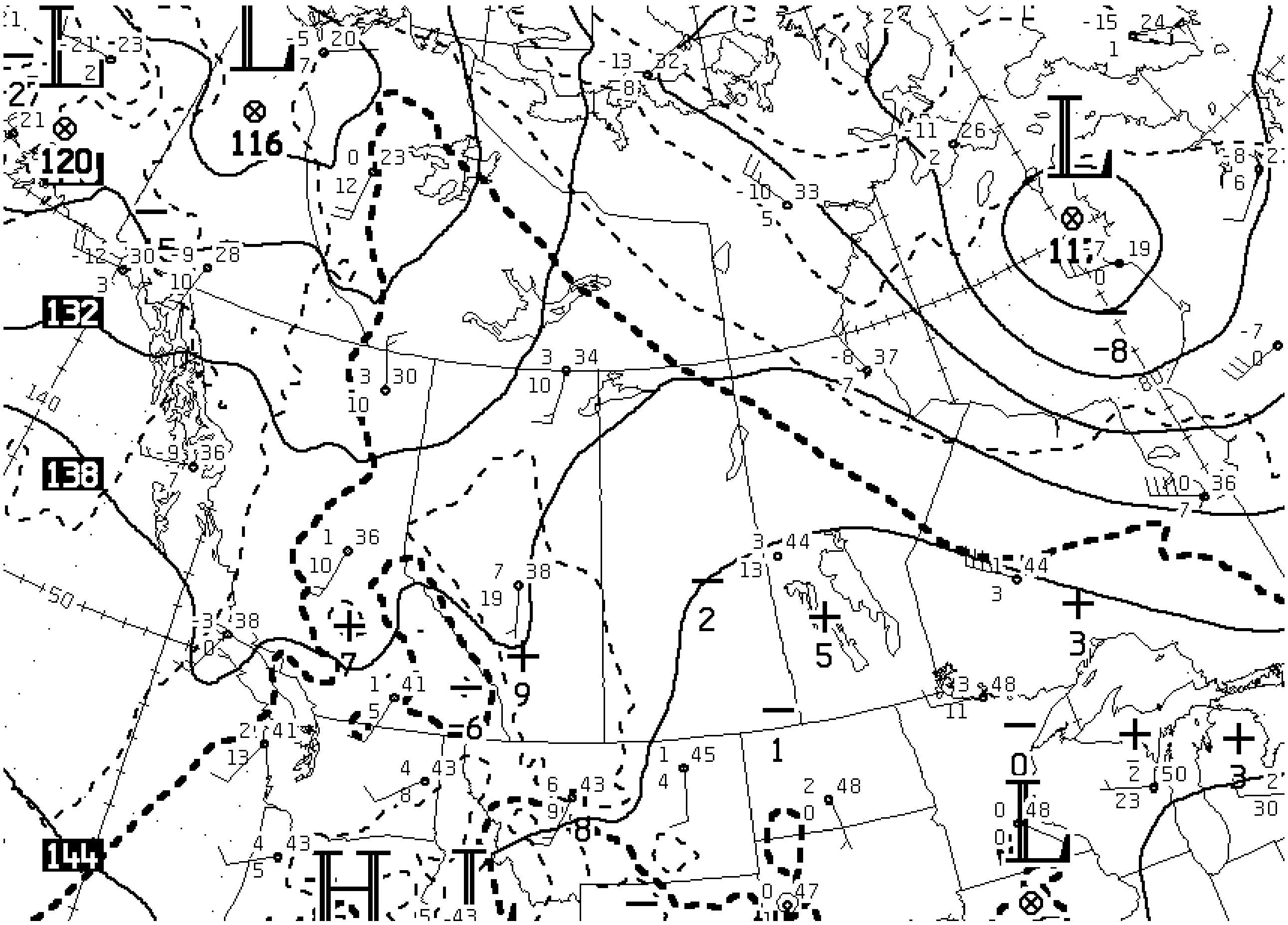

Figure 1: CMC 850 hPa analysis for 12Z on Saturday 7 Mar., 2010.

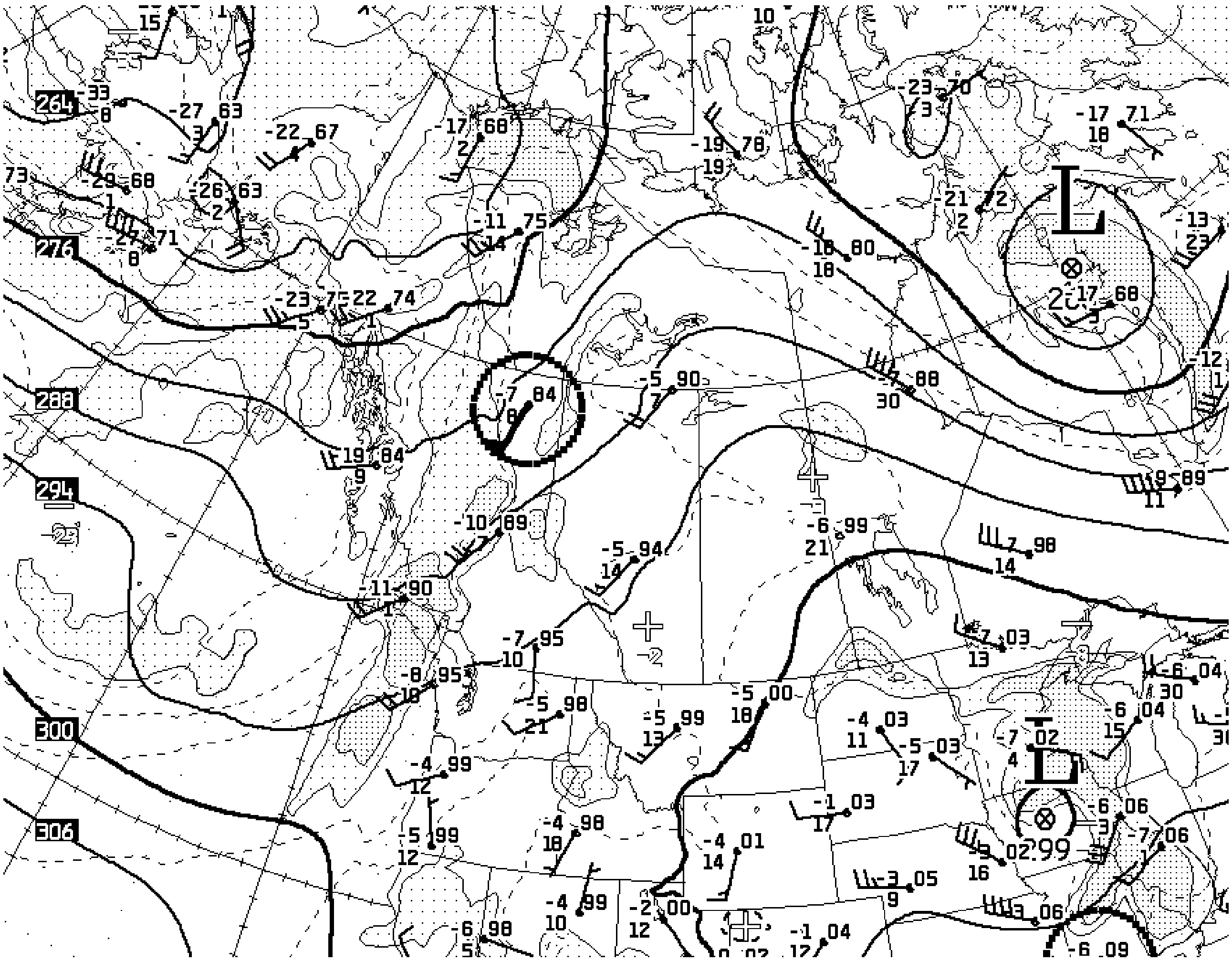

Figure 2: CMC 700 hPa analysis for 12Z on Saturday 7 Mar., 2010.

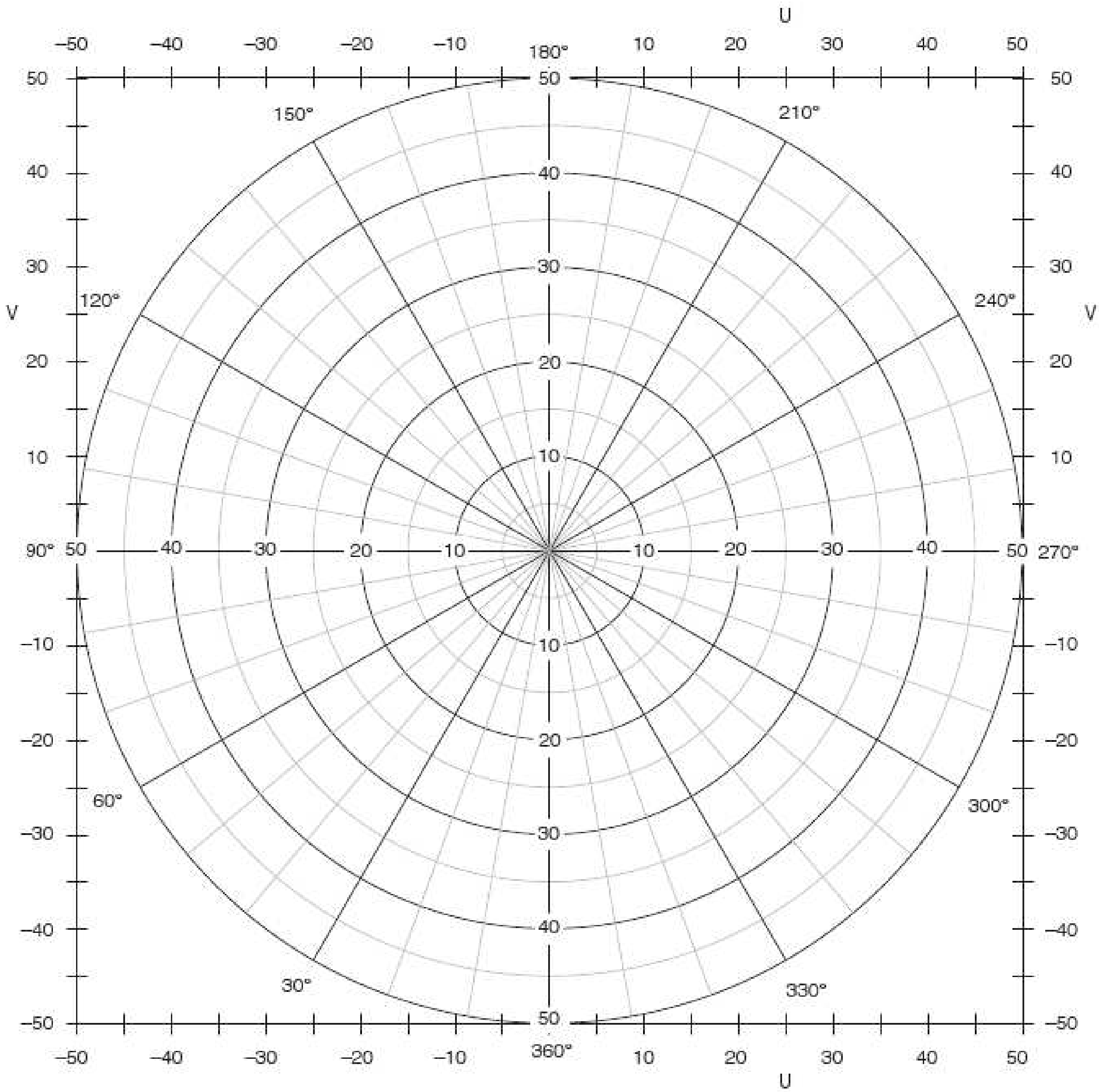

Figure 3: Blank hodograph (courtesy R. Stull, UBC).

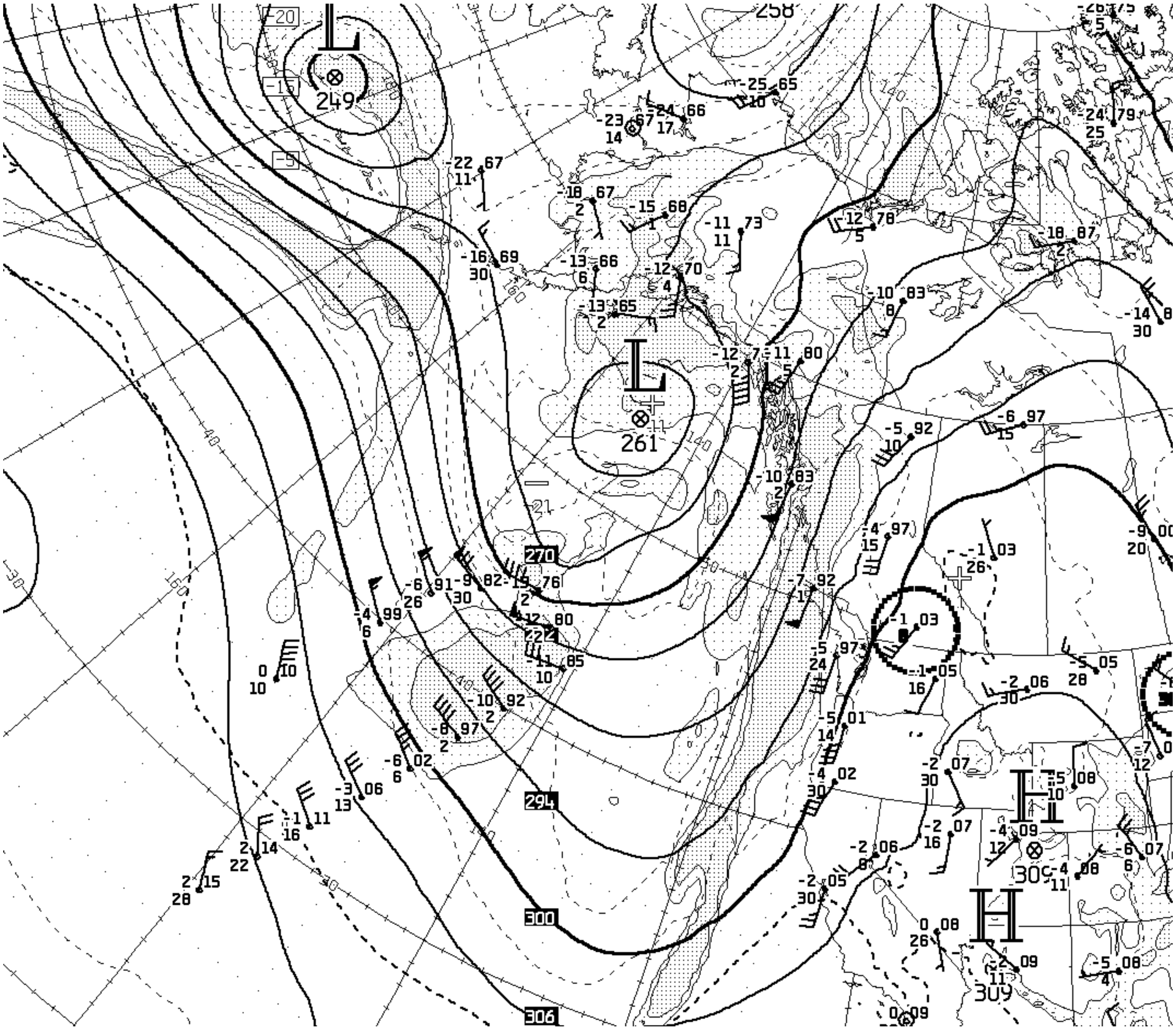

Figure 4: CMC 700 hPa analysis for 00Z on 2 Mar., 2010.