EAS372 Open book Mid-term Exam 17 Mar., 2011

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

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

A. Web weather/climate data (6 x 1/2 → 3%)

To answer the following questions, please use whatever web resources best suit (e.g. CMC analyses, text data for Stony Plain sounding, etc).

1. At 00Z today the 850 hPa height at Edmonton was ____ and the dewpoint at that level was ____
2. Describe the 850 hPa thermal pattern over central Alberta at 00Z today
3. Describe the 700 hPa wind over central Alberta at 00Z today
4. Using the coded format, write down the METAR for Edmonton International Airport (CYEG) for 00Z today
5. For the 71-2000 normals, the weather station titled "Lethbridge CDA" reported ____ annual total hours of bright sunshine
6. The Stony Plain (Edmonton) sounding for 12Z on July 15th, 2010 reported that temperature and dewpoint at 500 hPa were:

B. Interpretation of weather charts. (1 x 4 → 4%)

During January 2011 Edmonton International Airport recorded a total of 63.7 cm of snow (only 8 of the 31 days did not register some snowfall). The highest daily total was 12.7 cm on January 8th. Referring to Figures (1 – 7), interpret the meteorological factors relevant to the snowfall event of January 8th.

C. Calculations (4 x 2 → 8 %)

1. Referring to the paired soundings of Figure (8), compute the effective rate of heat loss per unit ground area.
2. Consider a snowpack of depth $D = 0.3$ m whose snow water equivalent ratio is $\alpha = 0.2$ and whose temperature is -10°C. Compute the mass and volume of water per unit ground area. Compute the amount of energy E_1 [J m^{-2}] required to bring the snowpack to the melting point. Compute the additional amount of energy E_2 [J m^{-2}] required to convert the snowpack to water.
3. Consider the series x_i, $i = 1...4$ whose values are $1, 3, -4, 9$. Compute the standard deviation of this series, defined $\sigma_x = \sqrt{\overline{x'^2}}$. Please show your working.

4. Plot the hodograph corresponding to Table (1) on the hodograph blank (Figure 9). Suggest the orientation of the isotherms at 850 hPa and the location of colder air relative to this station.

Table 1: YQD sounding 00Z Mar. 11, 2011.

p,hPa	z,m ASL	dir	spd,knots
973.2	305	120	10
925.0	705	150	17
900.5	914	175	14
850.0	1368	175	10
801.7	1829	235	12
765.0	2198	256	16
700.0	2888	270	23

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
- Properties of water: density $\rho_w = 1000\,\mathrm{kg\,m^{-3}}$, specific heat capacity $c_w = 4186\,\mathrm{J\,kg^{-1}\,K^{-1}}$, latent heat of freezing $L_f = 0.334 \times 10^6\,\mathrm{J\,kg^{-1}}$
- $p = \rho\ R\ T$, the ideal gas law. p [Pascals], pressure; ρ, [kg m^{-3}] the density; T [Kelvin], the temperature; and $R = 287$ [J kg^{-1} K^{-1}], the specific gas constant for air.
- $e = \rho_v\ R_v\ T$, 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.
- the saturation vapour pressure at temperature T is given by

$$\begin{aligned} e_*(T) &\approx 610.78\ \exp\ \frac{19.8\ T}{273+T}\ \text{(over water)}\ , \\ &\approx 610.78\ \exp\ \frac{22.5\ T}{273+T}\ \text{(over ice)}\ , \end{aligned}$$

  where T is to be entered in degrees Celcius and e is in [Pa].

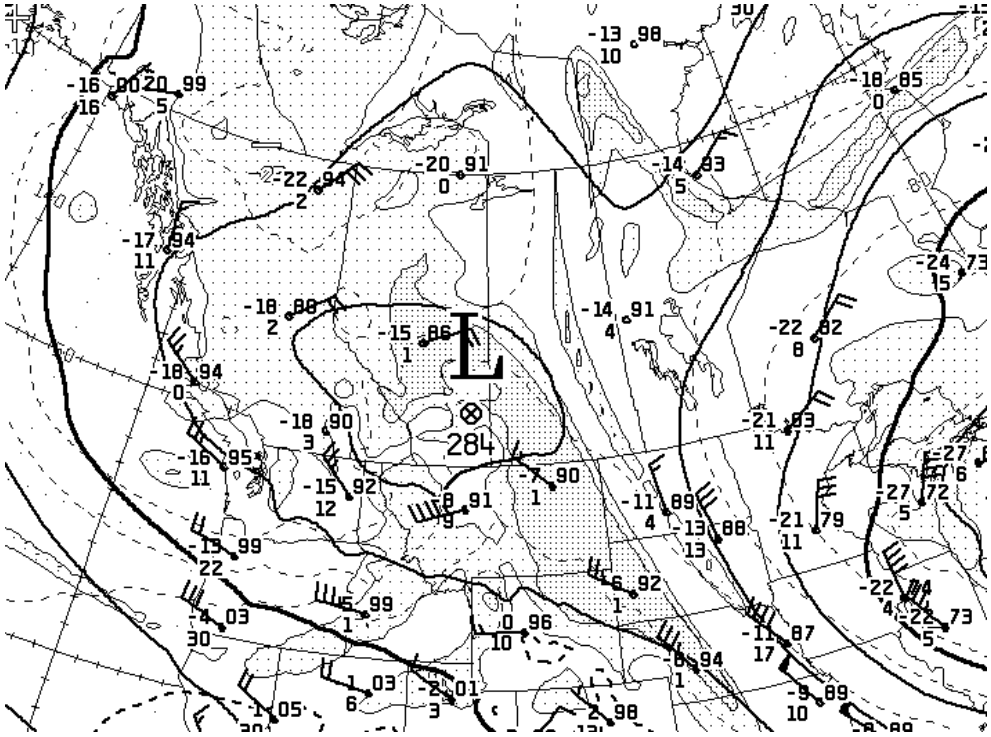

Figure 1: CMC 700 hPa analysis for 12Z Jan. 8th, 2011.

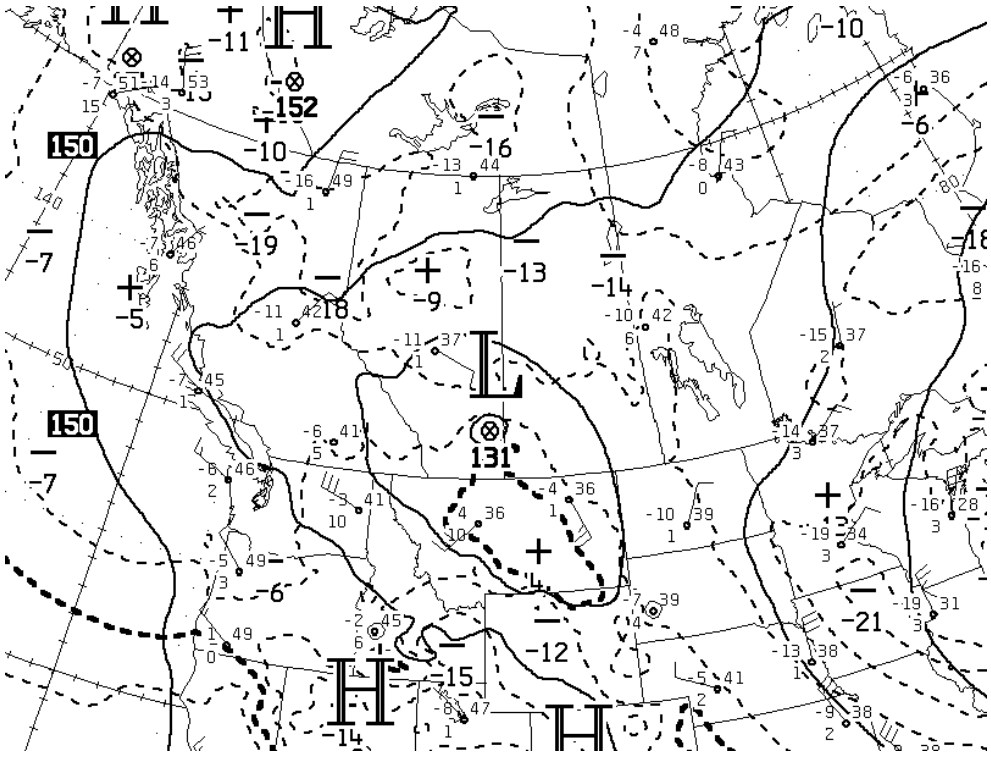

Figure 2: CMC 850 hPa analyses for 12Z Jan. 8th, 2011.

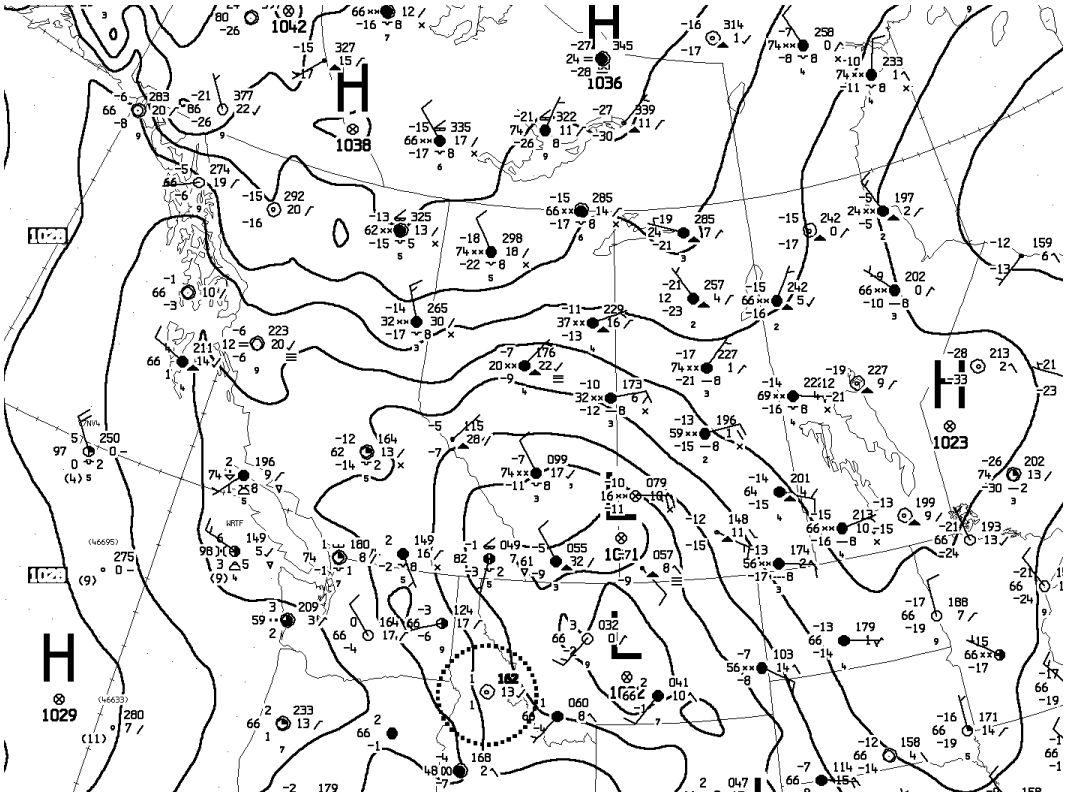

Figure 3: CMC sfc analysis for 12Z Jan. 8th, 2011.

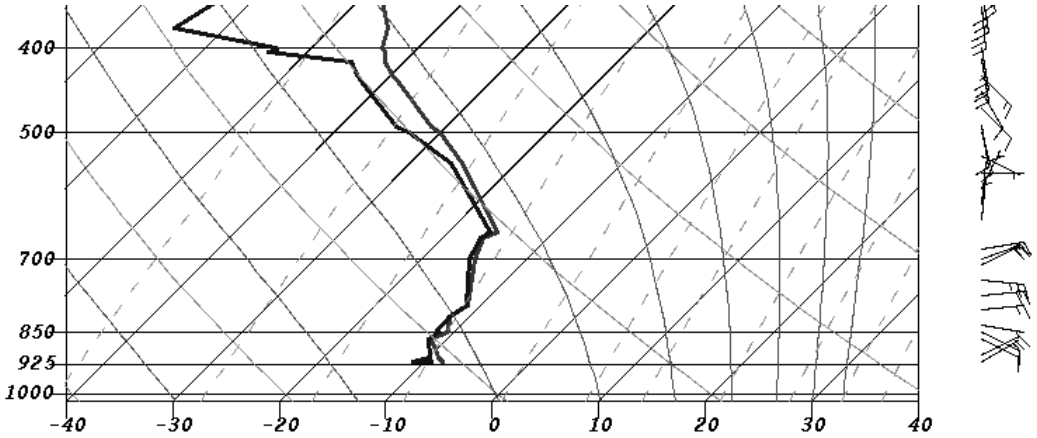

Figure 4: Edmonton sounding, for 12Z Jan. 8th, 2011.

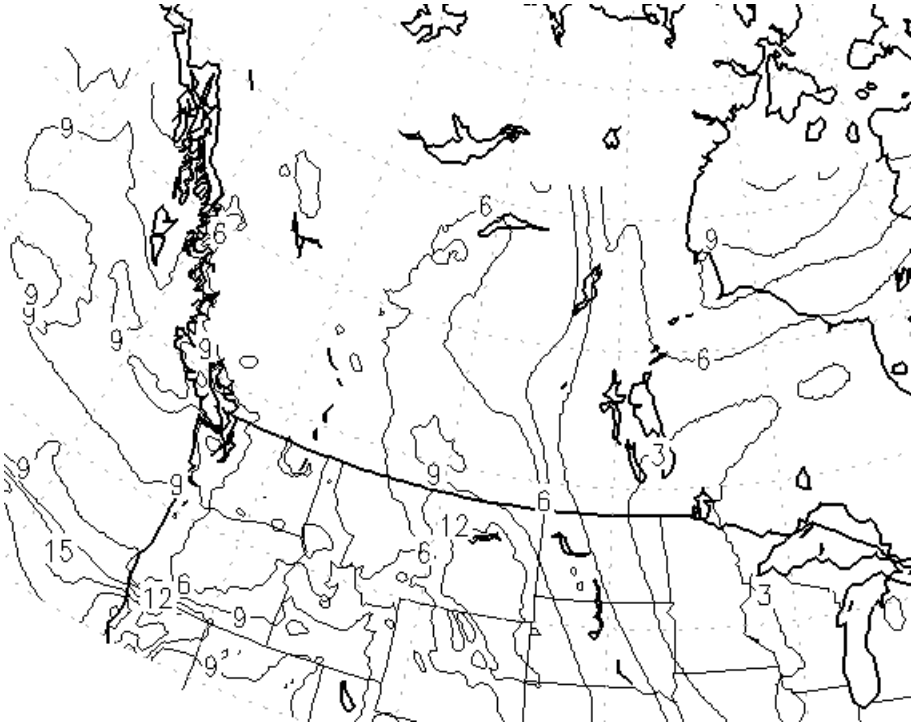

Figure 5: Reconstructed NAM analysis: precipitable water ($\mathrm{kg\,m^{-2}}$), 12Z Jan 8th, 2011.

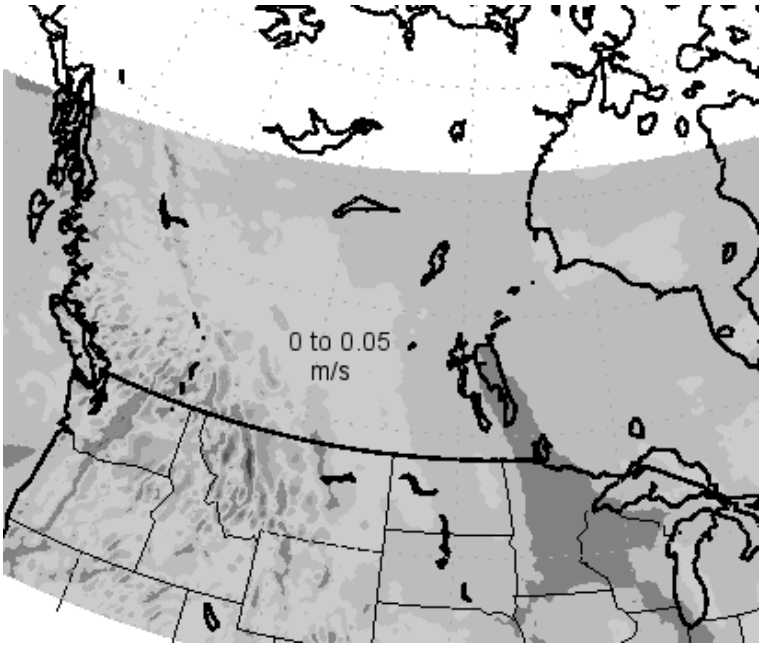

Figure 6: Reconstructed NAM analysis: vertical velocity ($\mathrm{m\,s^{-1}}$), 12Z Jan 8th, 2011.

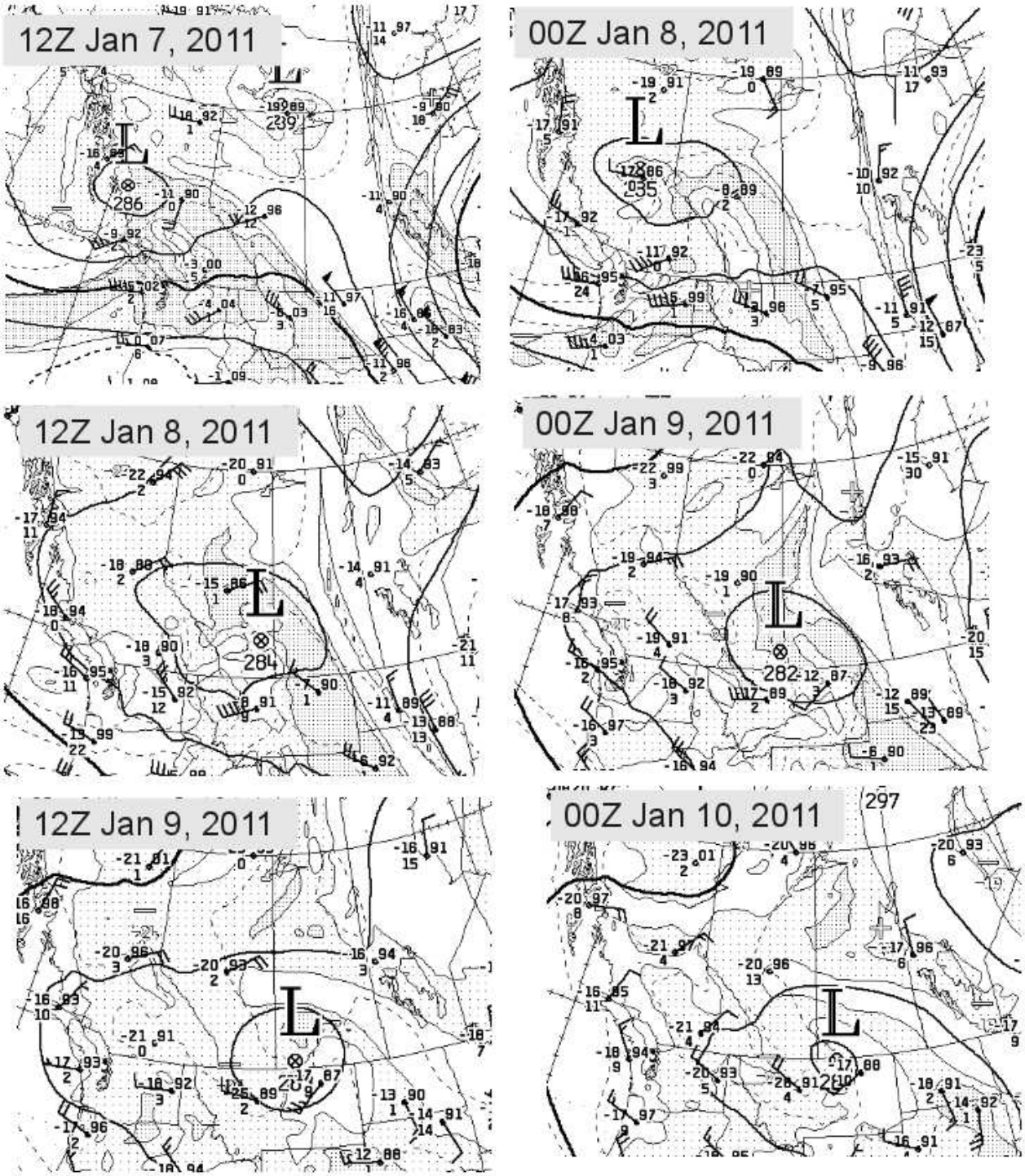

Figure 7: Sequence of CMC 700 hPa analyses, January 2011.

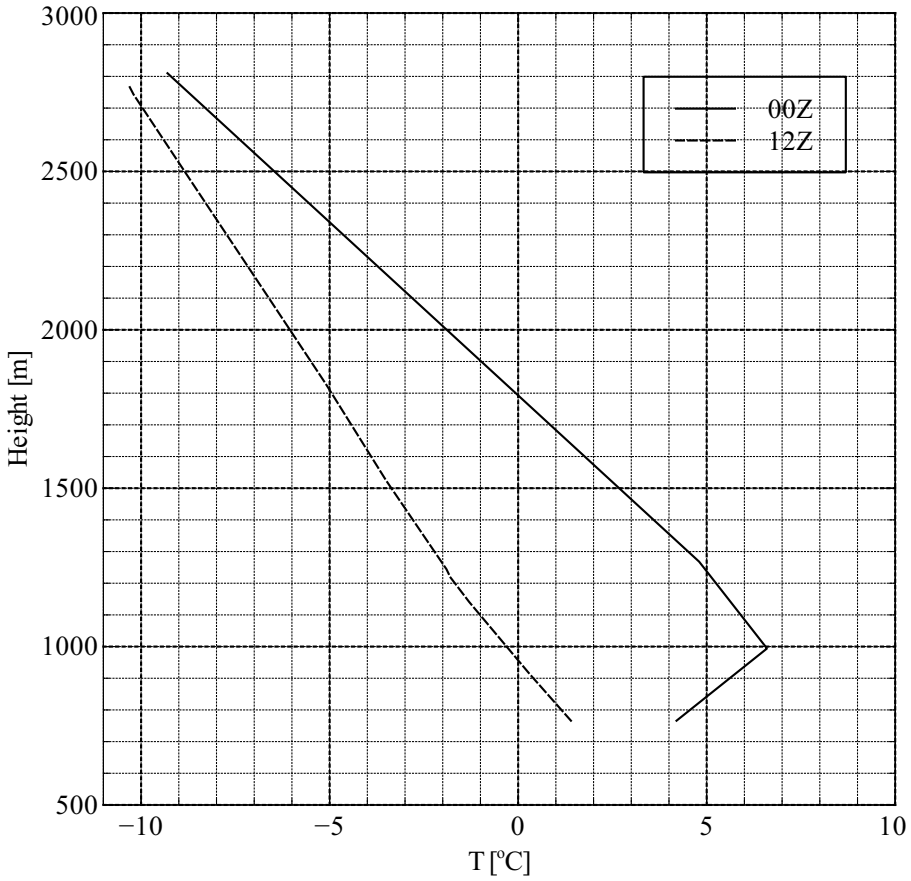

Figure 8: Edmonton soundings for 00Z & 12Z on Feb. 13th, 2011.

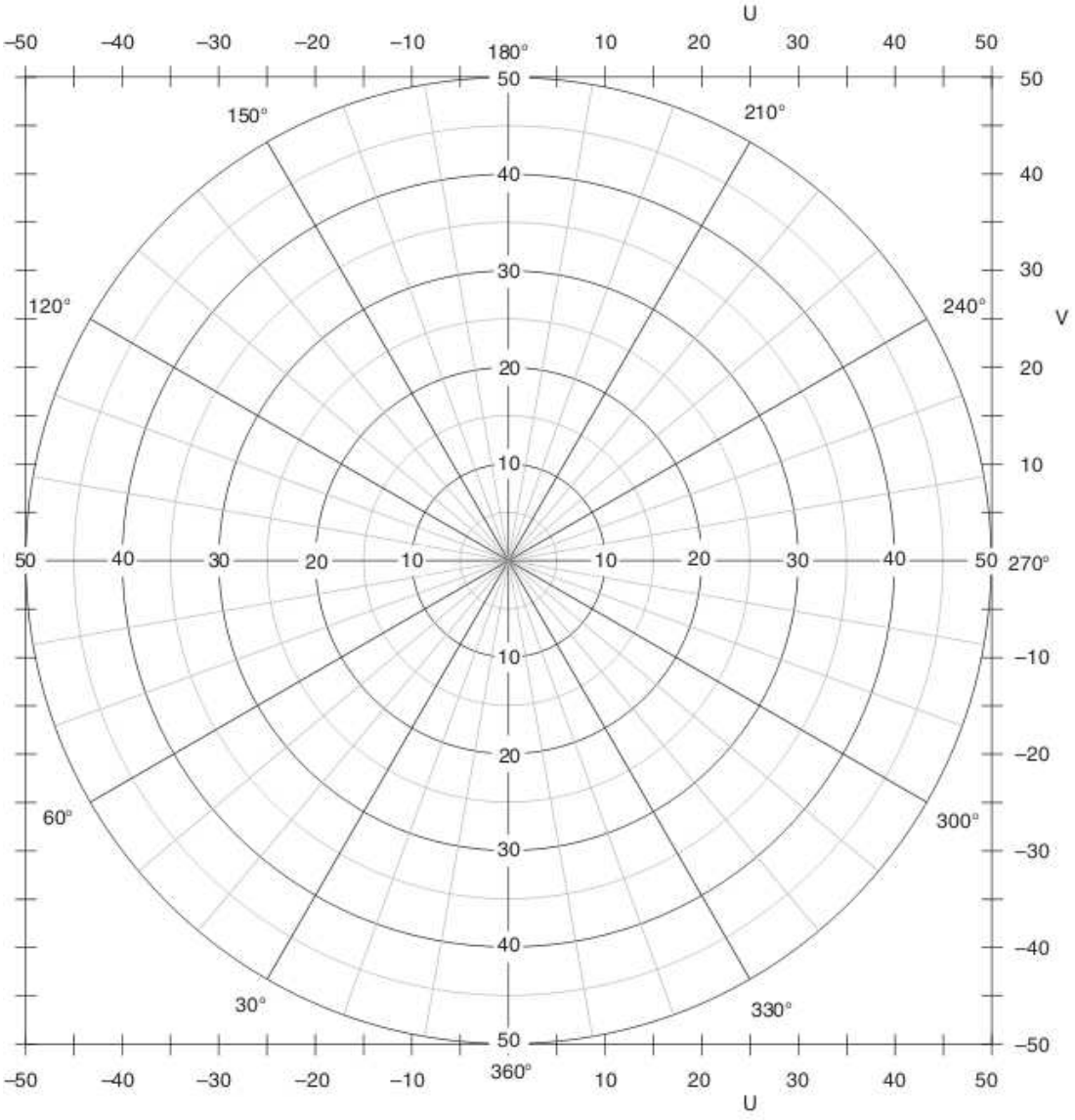

Figure 9: Blank hodograph (courtesy R. Stull).