ATSC 201 Fall 2025
Chapter 9: A1g, A7c, A8g, A10all
Chapter 12: A7g, A8g, A11g
Total marks: 54 marks

Chapter 9

A1g)
(4 marks)

Find the pressure "reduced to sea level" using the following station observations of pressure, height, and virtual temperature. Assume no
temperature change over the past 12 hours: g) P = 90 kPa, z = 980 m, Tv = 15 degC.

Given:	Pstn (kPa) =	90
	zstn (m) =	980
	Tv (degC) =	15
	Tv (K) =	288.15

Find: PMSL = ? kPa

First, use eqn 9.2:

$$\overline{T_v^*} = 0.5 \cdot [T_v(t_o) + T_v(t_o - 12\text{ h}) + \gamma_{sa} \cdot z_{stn}]$$

where Ysa = 0.0065 K/m
and Tv(to - 12h) = Tv(to) = 288.15 K

av Tv* = 291.34 K

Use eqn. 9.1:

$$P_{MSL} = P_{stn} \cdot \exp\left(\frac{z_{stn}}{a \cdot \overline{T_v^*}}\right)$$

where a = 29.3 m/K

PMSL = 100.9 kPa

Check: Units ok. Physics ok.

Discussion: At some stations, the PMSL may be located below the ground.

A7c)
(5 marks)

Photocopy the USA weather map in Fig. 9.19, and analyze it by drawing
isopleths for: c) dew point (isodrosotherms) every 5 degF

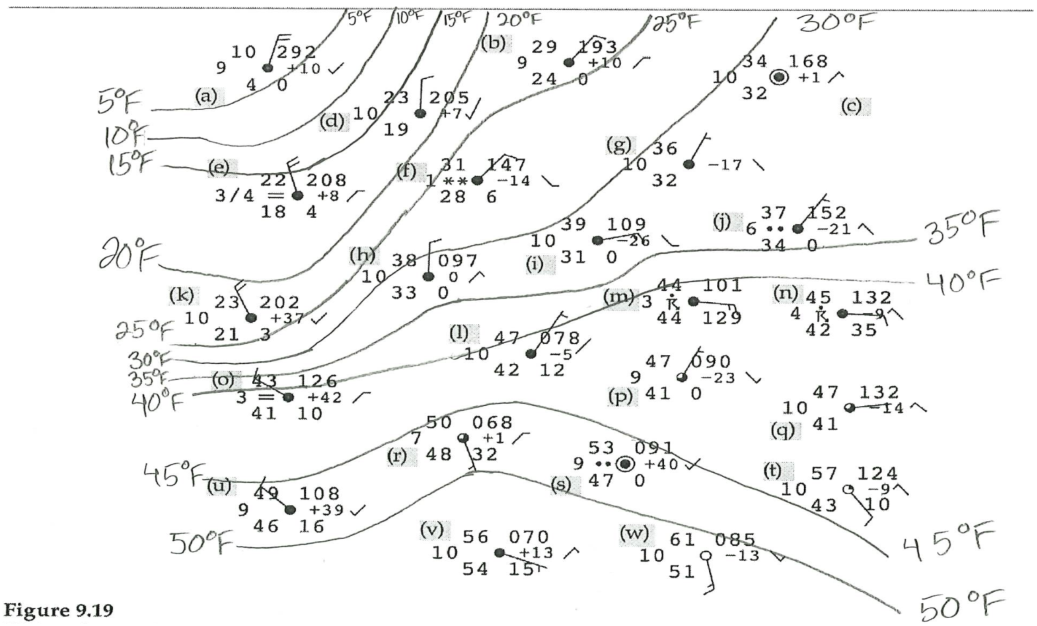


Figure 9.19

Check: Shapes of the isotherms make sense. They don't cross each other.

Discussion: The strong moisture gradient in the west likely represents a frontal boundary.

A8g)
(10 marks)

T	13 deg C
P	101.43 kPa
visibility = 24	km
vis = 74	
visibility = vis - 50 (for 56 ≤ vis ≤ 80)	
Td	7 degC
current wx	light rain
low cloud	stratocumulus (not from spreading cu)
Nh (low cloud cover)	8 oktas (eighths)
cloud-base height	1,000-1,499 m
past wx	showers
ΔP	0.02 kPa
P tendency	falling/steady, later rising OR rising slowly, later rising faster
total cloud cover	8 oktas (eighths) or "overcast"
wind speed	5 knots
wind direction	from northeast

Discussion: Using a map with multiple station plots, we can easily draw the isobars, isotherms, cloud coverage, and precipitation regions. We can then use analysis to infer where the low pressure centre and its associated cold and warm fronts are.

A10all)

(14 marks)

A10. Both of the weather maps of Fig. 9.21 correspond to the same weather. Do the following work on a photocopy of these charts:

a. Draw isotherms and identify warm and cold centers. Label isotherms every 2°C.
b. Draw isobars every 0.2 kPa and identify high and low pressure centers.
c. Add likely wind vectors to the pressure chart.
d. Identify the frontal zone(s) and draw the frontal boundary on the temperature chart.
e. Use both charts to determine the type of front (cold, warm), and draw the appropriate frontal symbols on the front.
f. Indicate likely regions for clouds and suggest cloud types in those regions.
g. Indicate likely regions for precipitation.
h. For which hemisphere are these maps?

Diagrams on next pages.

Discussion: Weather forecasters in training at Environment Canada have to draw diagrams like this every morning!

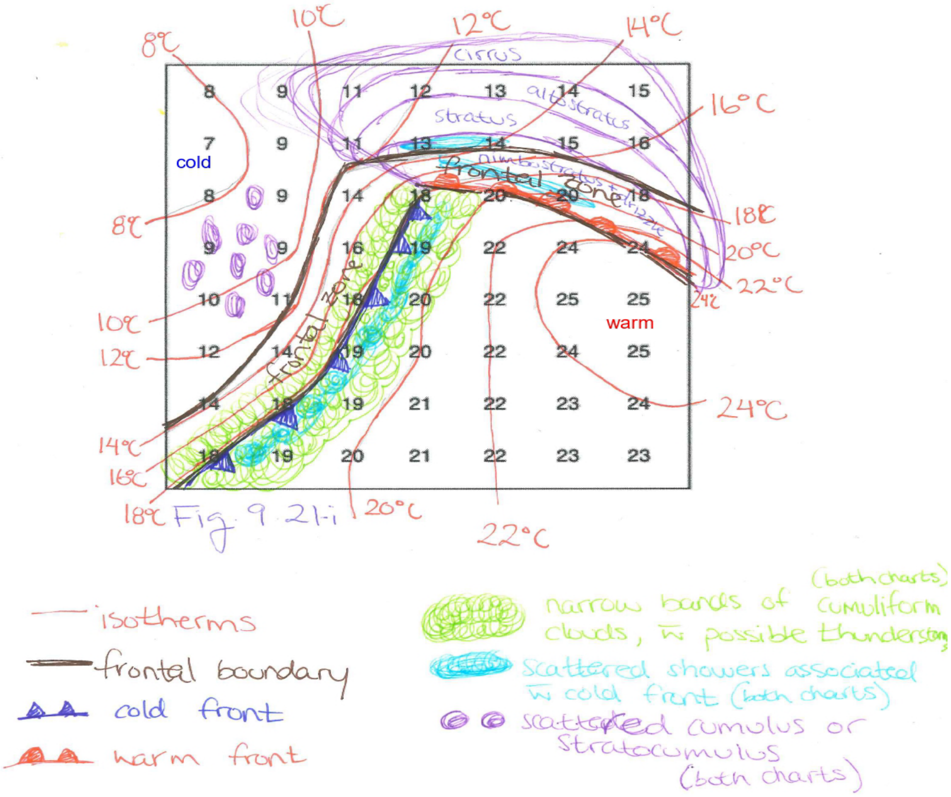

cold
warm
8°C
10°C
12°C
14°C
16°C
18°C
20°C
22°C
24°C
cirrus
altostratus
stratus
nimbostratus
frontal zone
frontal zone
isotherms
frontal boundary
cold front
warm front
narrow bands of cumuliform clouds, w/ possible thunderstorms (both charts)
scattered showers associated w/ cold front (both charts)
scattered cumulus or stratocumulus (both charts)

Fig. 9.21-i

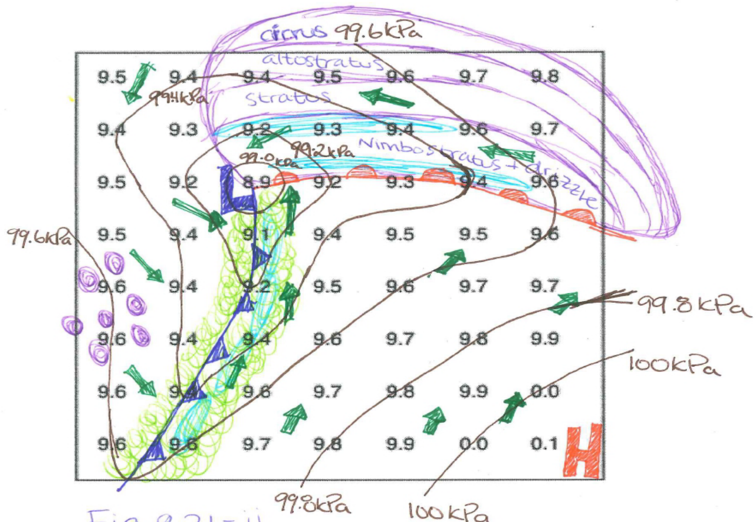


Fig. 9.21-ii

— isobars

L low pressure center

H high pressure center

→ wind vectors

stratiform clouds preceding a warm front (see chart for types of stratiform clouds)

rain bands associated w nimbostratus (both charts)

Chapter 12

A7g) (4.5 marks)

Find the external Rossby radius of deformation at 60° latitude for a cold airmass of thickness 500m and Δθ (°C) of: g) 14. Assume a background temperature of 300K.

Given:	Δθ (°C) =	14	or 14K because it's a difference
	ϕ (°) =	60	
	H (m) =	500	
	T (K) =	300	

Use eqn. 12.5: $$a = \lambda_R = \frac{\sqrt{|g| \cdot H \cdot \Delta\theta_v / \overline{T_v}}}{f_c}$$

where g = 9.8 m/s^2

To find fc use eqn 10.16: fc = 2*Ω*sinϕ
where Ω = 7.29E-05 /s

fc = 1.26E-04 /s

Assume a dry air mass so that Δθ ~= Δθv, and T ~= Tv.

λR (m) =	**1.20E+05**	**m**
	119.76	**km**

Check: Units ok. Physics ok.
Discussion: above the external Rossby radius of deformation is where the jet stream would be. The fact that cold air masses cannot redistribute cold air to the equator means some other forces will try to redistribute this heat

A8) (9.5 marks)

Find and plot the airmass depth and geostrophic wind as a function of distance from the front for the cases of the previous exercise. Assume a temperature of 300K.

Given:		
	Δθ (°C) =	14
	ϕ (°) =	60
	H (m) =	500
	T (K) =	300

From A7d the final spillage distance of the front a = λR = 110.88 km.

a (m) = 1.20E+05

Use eqn 12.6:

$$U_g = -\sqrt{|g| \cdot H \cdot (\Delta\theta_v / \overline{T_v})} \cdot \exp\left(-\frac{y+a}{a}\right)$$

where y is the distance behind a.
and g = 9.8 m/s^2

Assume a dry air mass so that Δθ ~= Δθv, and T ~= Tv.

Use eqn 12.7:

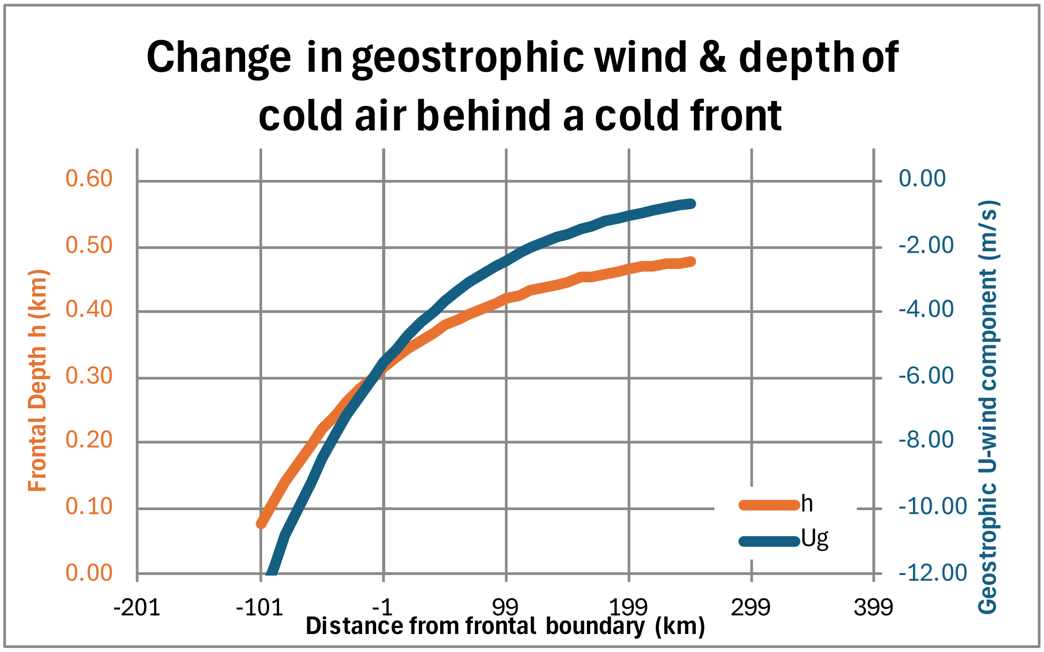
$$h = H \cdot \left[1 - \exp\left(-\frac{y+a}{a}\right)\right]$$

y (km)	Ug (m/s)	h (km)
-100	*-12.82*	*0.0761*
-90	*-11.79*	*0.1100*
-80	*-10.85*	*0.1413*
-70	*-9.98*	*0.1700*
-60	*-9.18*	*0.1964*
-50	*-8.45*	*0.2207*
-40	*-7.77*	*0.2431*
-30	*-7.15*	*0.2637*
-20	*-6.57*	*0.2826*
-10	*-6.05*	*0.3000*
0	*-5.56*	*0.3161*
10	*-5.12*	*0.3308*
20	*-4.71*	*0.3444*
30	*-4.33*	*0.3568*
40	*-3.98*	*0.3683*

50	*-3.66*	*0.3788*
60	*-3.37*	*0.3885*
70	*-3.10*	*0.3975*
80	*-2.85*	*0.4057*
90	*-2.62*	*0.4132*
100	*-2.41*	*0.4202*
110	*-2.22*	*0.4266*
120	*-2.04*	*0.4325*
130	*-1.88*	*0.4379*
140	*-1.73*	*0.4429*
150	*-1.59*	*0.4474*
160	*-1.46*	*0.4516*
170	*-1.35*	*0.4555*
180	*-1.24*	*0.4591*
190	*-1.14*	*0.4624*
200	*-1.05*	*0.4654*
210	*-0.96*	*0.4681*
220	*-0.89*	*0.4707*
230	*-0.82*	*0.4730*
240	*-0.75*	*0.4752*
250	*-0.69*	*0.4772*

Check: Units ok. Physics ok.

Discussion: this h vs y plot confirms Fig. 12.17b, where the depth of the cold air mass increases with distance into the cold air mass. Fig 12.17b also shows Ug being strongest at the air mass boundary (y=-a) and then decreasing in strength further back into the cold air mass.



Change in geostrophic wind & depth of cold air behind a cold front
Frontal Depth h (km)
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
Geostrophic U-wind component (m/s)
-201
-101
-1
99
199
299
399
Distance from frontal boundary (km)
h
Ug

A11g)
(7 marks)

Plot dryline movement with time, given the following conditions. Surface heat flux is constant with time at kinematic rate 0.2 K*m/s. The vertical gradient of potential temperature in the initial sounding is Y. Terrain slope is s = Δz/Δx. g) Y (K/km) = 12, s = 1/300.

Given:	Y =		12	K/km	0.012 K/m
	s =	1/300 =	0.003333		
	FH =		0.2	K*m/s	

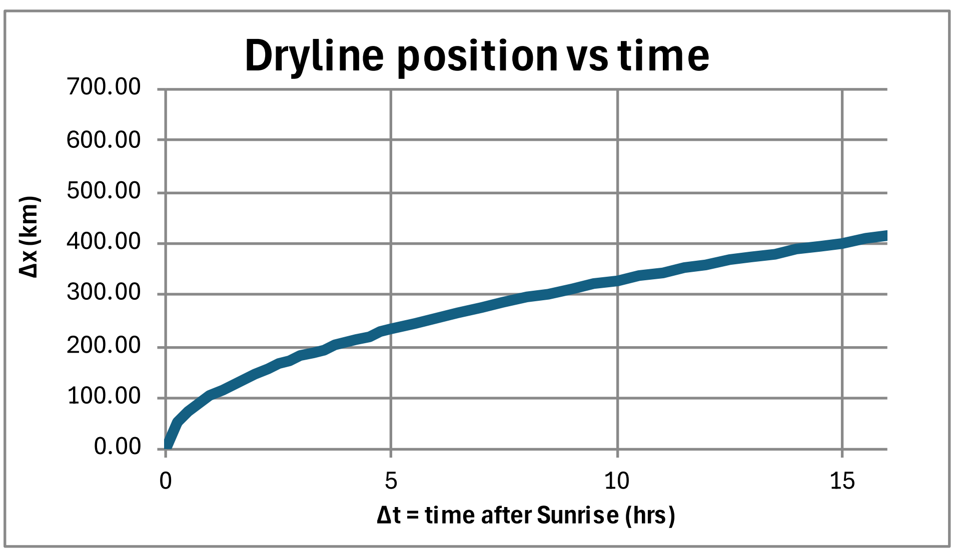
Plot Δx vs Δt (the dryline movement with time).

From Sample Application, QAK = FH*Δt.

Use eqn 12.15:

$$\Delta x = \frac{1}{s} \cdot \left(\frac{2 \cdot Q_{Ak}}{\gamma} \right)^{1/2}$$

Δt (hrs)	**Δx (km)**
0	0.00
0.25	51.96
0.5	73.48
0.75	90.00
1	103.92
1.25	116.19
1.5	127.28
1.75	137.48
2	146.97
2.25	155.88
2.5	164.32
2.75	172.34
3	180.00
3.25	187.35
3.5	194.42
3.75	201.25
4	207.85
4.25	214.24
4.5	220.45
4.75	226.50
5	232.38
5.5	243.72
6	254.56



6.5	264.95
7	274.95
7.5	284.60
8	293.94
8.5	302.99
9	311.77
9.5	320.31
10	328.63
10.5	336.75
11	344.67
11.5	352.42
12	360.00
12.5	367.42
13	374.70
13.5	381.84
14	388.84
14.5	395.73
15	402.49
15.5	409.15
16	415.69

Check: Units ok. Physics ok.

Discussion: This plot does not take into account night time, when convective turbulence ceases and prevailing low altitude easterlies advect moist air back towards the west.