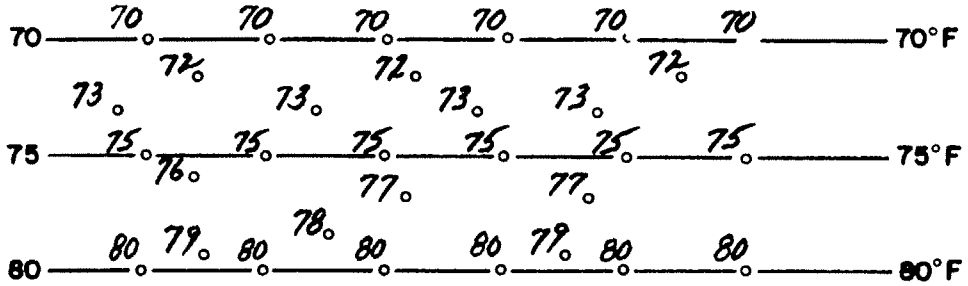
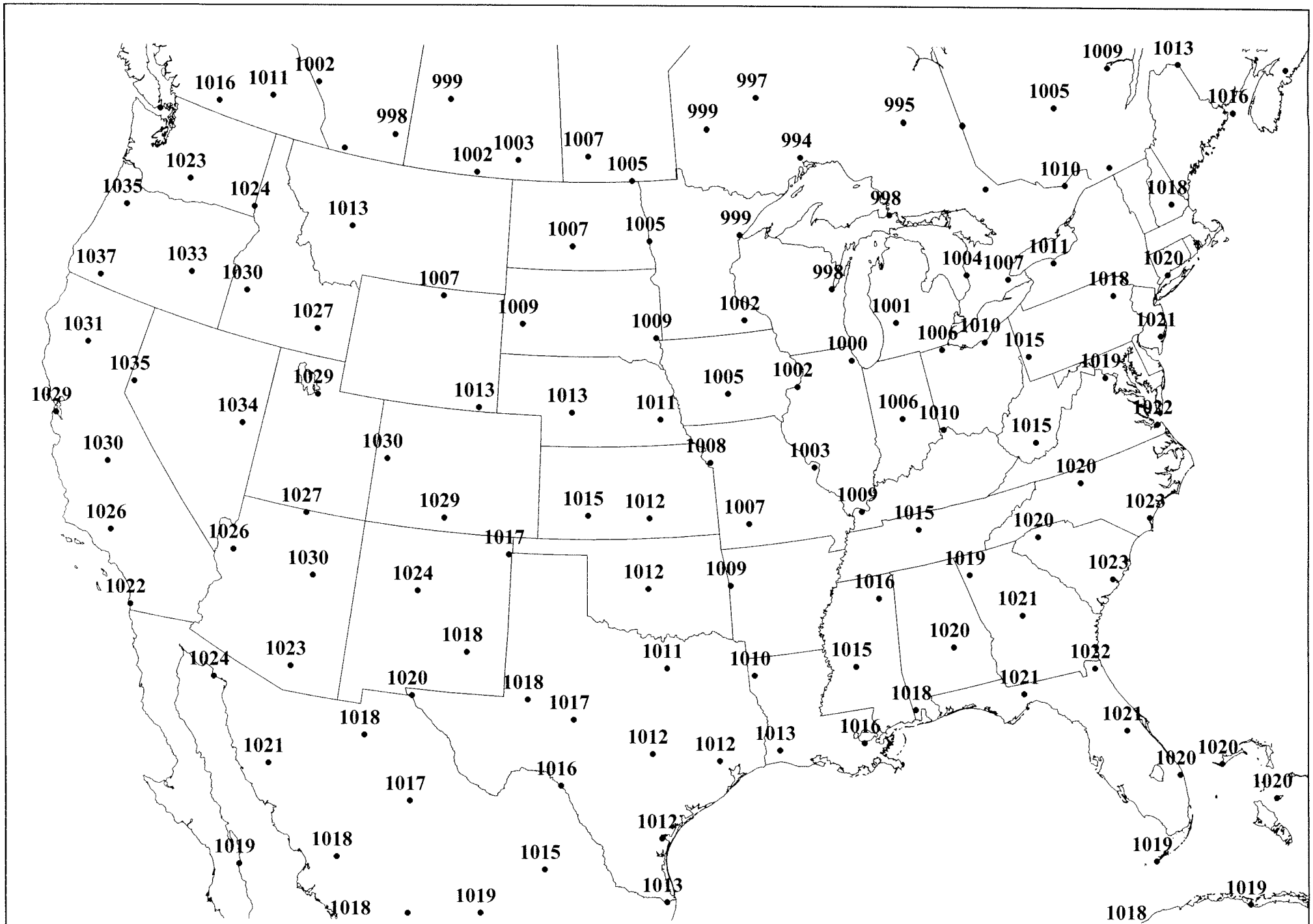
Isoplething

Connecting equal values of a particular meteorological variable. An example for isotherms is shown below.



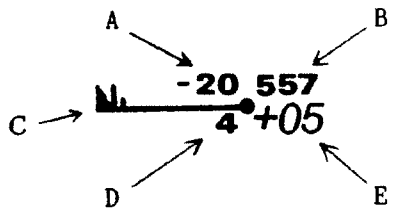
Drawing isopleths for isobars or contours (lines of constant geopotential height) is somewhat similar. An example for you to complete as a homework assignment is shown on the next page. Draw the isobars every 4 mb (i.e., 1000, 996, 992. etc.).

Drawing isobars or contours is different than drawing other scalar fields since you **MUST TAKE THE WINDFIELD INTO ACCOUNT**. At the 500 mb level, the contours or isobars are drawn approximately parallel to the wind direction since the flow is close to being geostrophic. This is not as stringent at other levels. Closer to the surface, the flow has a component of flow toward low pressures due to friction. At higher levels near the jet stream, the flow is accelerating and decelerating so it also deviates from geostrophy (recall the geostrophic flow is non-accelerating flow).



Contouring Isobars Exercise

Upper Air Plotting Model



Height Values(meters)

850mb Chart: Add 1000 to "B"
700mb Chart: Add 2000 if 300≤"B"≤999
Add 3000 if 000≤"B"≤299
500mb Chart: Add a zero next to last digit
250mb Chart: Add a zero next to last digit
Also add 10000 if 000≤"B"≤200

A) Air temperature rounded to nearest whole degree Celsius

B) Height of constant pressure surface in meters on 850mb and 700mb charts; in tens of meters(decameters) on 500mb and 250mb charts
Highest order digit is omitted whenever the height will not fit in the 3 digit space allotted on 850mb, 700mb, and 250mb charts. On 500mb and 250mb charts the lowest order digit is also omitted.

C) Wind speed determined by the sum of values of pennants and/or barbs on the arrow.(Station circle acts as the arrow head.)
A pennant( )=50 knots; a barb( )=10 knots; a half barb( )=5 knots
When wind speed is less than 3 knots, "LV" is plotted.
The arrow points in the direction that the wind is blowing toward.
(NOTE: METEOROLOGISTS DEFINE WIND DIRECTION AS FROM WHERE THE AIR IS BLOWING INSTEAD OF TOWARD WHERE IT IS BLOWING.)

D) Dew point depression(DD) in whole degrees Celsius; Subtract number from air temperature to get dew point. When DD is <6°C, the station circle is darkened in so that regions of high moisture content will stand out. When DD is >29°C, "X" is plotted. DD will be missing when air temp. is colder than -40°C. (This does not apply to Canadian and some U.S. military stations.)

E) 12 hour height change in decameters; a "+" shows a height rise while a "-" shows a height fall.

Temperature or height which has been estimated for high altitude stations (especially at 850mb level) is marked with a dotted bracket,"]", to the right of the calculated value. A bracket is also marked for any reported value judged erroneous by the monitoring analyst.

On the 250mb chart isotach(lines of constant wind speed) regions are hatched in increments of 40 knots for speeds 70 knots or higher. This allows for easy location of jet streams when viewing the chart.

Aircraft reports are identified by a square rather than a cirle, and a star denotes a satellite derived wind estimate. Regular aircraft reports give heights in hundreds of feet while reconnaisance planes(an "R" is printed under the station square) report heights in the manner described above. The satellite height is estimated based on cloud top tempeartures(heights reported in hundreds of feet). The number on the lower left side of the satellite wind is the time(UTC) that the report is valid.

What is Geopotential Height?

Values of the geometric height (z), geopotential height (Z), and acceleration due to gravity (g) at 40° latitude

z (km)	Z (km)	g (m s^{-2})
0	0	9.802
1	1.000	9.798
10	9.986	9.771
20	19.941	9.741
30	29.864	9.710
60	59.449	9.620
90	88.758	9.531
120	117.795	9.443
160	156.096	9.327
200	193.928	9.214
300	286.520	8.940
400	376.370	8.677
500	463.597	8.427
600	548.314	8.186

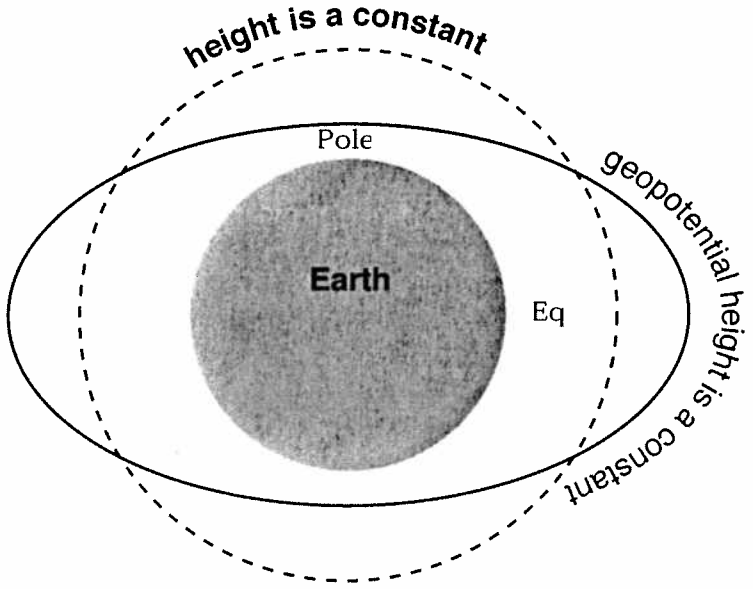
$$geopotential \quad height = Z = \frac{1}{9.8ms^{-2}} \int_0^z g\,dz$$

$$hydrostatic \quad equation = \frac{dp}{dz} = -\rho g = \frac{pg}{R_d T_v}$$

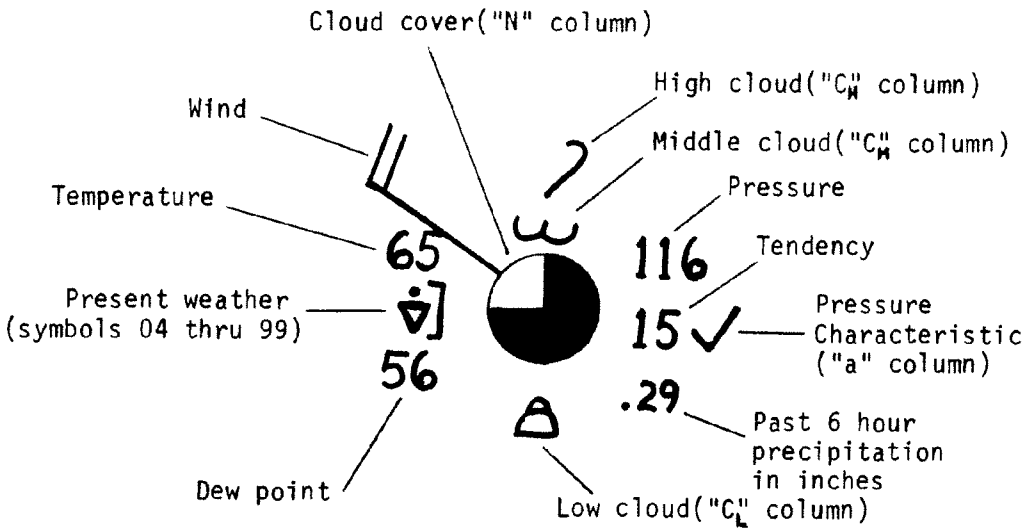
$$Z = \frac{R_d}{9.8ms^{-2}} \int T_v \frac{dp}{p}$$

The above equation for geopotential height can be easily calculated if you have data from a radiosonde (i.e., data that provides information of temperature and pressure with height).

\



Surface Plotting Model



Temperature : Observed air temperature in Fahrenheit but in Celsius on Pacific surface analysis

Dew point : Same units as for temperature

Pressure : Equivalent sea level pressure
Pressure is given in tenths of millibars with the initial 9 or 10 omitted.(Generally, if initial number is 0 to 4, put a 10 in front of the 3 digits to read the pressure value; Otherwise, put a 9 in the front position. For example : 096 = 1009.6mb 960 = 996.0mb)

Tendency : Pressure change in the past 3 hours in tenths of millibars. The symbol following the number describes how the pressure has changed in the past 3 hours.

Wind : Wind direction and speed is represented in the same manner as on the upper air charts. (Exception : wind speed under 3 knots is shown by a concentric circle around station circle.)

STATION MODEL AND EXPLANATION OF WEATHER C

§The symbol is not plotted for "ww" when "OO" is reported. When "01, 02, or 03" is reported for "ww", the symbol is plotted on the station circle.
†Refers to "hail" only. ††Refers to "soft hail", "small hail", and "hail".

ww

Present weather

00 Cloud development NOT observed or NOT observable during past hour.§	**01** Clouds generally dissolving or becoming less developed during past hour.§	**02** State of sky on the whole unchanged during past hour.§	**03** Clouds generally forming or developing during past hour.§	**04** Visibility reduced by smoke.	**05** Haze.	**06** Widespread dust in suspension in the air, NOT raised by wind, at time of observation.	**07** Dust or sand raised by wind, at time of ob.	**08** Well developed dust devil(s) within past hr.	**09** Duststorm or sandstorm within sight of or at station during past hour.
10 Light fog.	**11** Patches of shallow fog at station, NOT deeper than 6 feet on land.	**12** More or less continuous shallow fog at station, NOT deeper than 6 feet on land.	**13** Lightning visible, no thunder heard.	**14** Precipitation within sight, but NOT reaching the ground.	**15** Precipitation within sight, reaching the ground, but distant from station.	**16** Precipitation within sight, reaching the ground, near to but NOT at station.	**17** Thunder heard, but no precipitation at the station.	**18** Squall(s) within sight during past hour.	**19** Funnel cloud(s) within sight during past hour.
20 Drizzle (NOT freezing and NOT falling as showers) during past hour, but NOT at time of ob.	**21** Rain (NOT freezing and NOT falling as showers) during past hr., but NOT at time of ob.	**22** Snow (NOT falling as showers) during past hr., but NOT at time of ob.	**23** Rain and snow (NOT falling as showers) during past hour, but NOT at time of observation.	**24** Freezing drizzle or freezing rain (NOT falling as showers) during past hour, but NOT at time of observation.	**25** Showers of rain during past hour, but NOT at time of observation.	**26** Showers of snow, or of rain and snow, during past hour, but NOT at time of observation.	**27** Showers of hail, or of hail and rain, during past hour, but NOT at time of observation.	**28** Fog during past hour, but NOT at time of ob.	**29** Thunderstorm (with or without precipitation) during past hour, but NOT at time of ob.
30 Slight or moderate duststorm or sandstorm, has decreased during past hour.	**31** Slight or moderate duststorm or sandstorm, no appreciable change during past hour.	**32** Slight or moderate duststorm or sandstorm, has increased during past hour.	**33** Severe duststorm or sandstorm, has decreased during past hr.	**34** Severe duststorm or sandstorm, no appreciable change during past hour.	**35** Severe duststorm or sandstorm, has increased during past hour.	**36** Slight or moderate drifting snow, generally low.	**37** Heavy drifting snow, generally low.	**38** Slight or moderate drifting snow, generally high.	**39** Heavy drifting snow, generally high.
40 Fog at distance at time of ob., but NOT at station during past hour.	**41** Fog in patches.	**42** Fog, sky discernible, has become thinner during past hour.	**43** Fog, sky NOT discernible, has become thinner during past hour.	**44** Fog, sky discernible, no appreciable change during past hour.	**45** Fog, sky NOT discernible, no appreciable change during past hour.	**46** Fog, sky discernible, has begun or become thicker during past hr.	**47** Fog, sky NOT discernible, has begun or become thicker during past hour.	**48** Fog, depositing rime, sky discernible.	**49** Fog, depositing rime, sky NOT discernible.
50 Intermittent drizzle (NOT freezing) slight at time of observation.	**51** Continuous drizzle (NOT freezing) slight at time of observation.	**52** Intermittent drizzle (NOT freezing) moderate at time of ob.	**53** Continuous drizzle (NOT freezing), moderate at time of ob.	**54** Intermittent drizzle (NOT freezing), thick at time of observation.	**55** Continuous drizzle (NOT freezing), thick at time of observation.	**56** Slight freezing drizzle.	**57** Moderate or thick freezing drizzle.	**58** Drizzle and rain, slight.	**59** Drizzle and rain, moderate or heavy.
60 Intermittent rain (NOT freezing), slight at time of observation.	**61** Continuous rain (NOT freezing), slight at time of observation.	**62** Intermittent rain (NOT freezing), moderate at time of ob.	**63** Continuous rain (NOT freezing), moderate at time of observation.	**64** Intermittent rain (NOT freezing), heavy at time of observation.	**65** Continuous rain (NOT freezing), heavy at time of observation.	**66** Slight freezing rain.	**67** Moderate or heavy freezing rain.	**68** Rain or drizzle and snow, slight.	**69** Rain or drizzle and snow, mod'te or heavy.
70 Intermittent fall of snow flakes, slight at time of observation.	**71** Continuous fall of snowflakes, slight at time of observation.	**72** Intermittent fall of snow flakes, moderate at time of observation.	**73** Continuous fall of snowflakes, moderate at time of observation.	**74** Intermittent fall of snow flakes, heavy at time of observation.	**75** Continuous fall of snowflakes, heavy at time of observation.	**76** Ice needles (with or without fog).	**77** Granular snow (with or without fog).	**78** Isolated starlike snow crystals (with or without fog).	**79** Ice pellets (sleet, U. S. definition).
80 Slight rain shower(s).	**81** Moderate or heavy rain shower(s).	**82** Violent rain shower(s).	**83** Slight shower(s) of rain and snow mixed.	**84** Moderate or heavy shower(s) of rain and snow mixed.	**85** Slight snow shower(s).	**86** Moderate or heavy snow shower(s).	**87** Slight shower(s) of soft or small hail with or without rain or rain and snow mixed.	**88** Moderate or heavy shower(s) of soft or small hail with or without rain or rain and snow mixed.	**89** Slight shower(s) of hail††, with or without rain or rain and snow mixed, not associated with thunder.
90 Moderate or heavy shower(s) of hail††, with or without rain or rain and snow mixed, not associated with thunder.	**91** Slight rain at time of ob.; thunderstorm during past hour, but NOT at time of observation.	**92** Moderate or heavy rain at time of ob.; thunderstorm during past hour, but NOT at time of observation.	**93** Slight snow or rain and snow mixed or hail† at time of observa.; thunderstorm during past hour, but not at time of observation.	**94** Mod. or heavy snow, or rain and snow mixed or hail† at time of ob.; thunderstorm during past hour, but NOT at time of observation.	**95** Slight or mod. thunderstorm without hail†, but with rain and/or snow at time of ob.	**96** Slight or mod. thunderstorm, with hail† at time of observation.	**97** Heavy thunderstorm, without hail†, but with rain and/or snow at time of observation.	**98** Thunderstorm combined with dustorm or sandstorm at time of ob.	**99** Heavy thunderstorm with hail† at time of ob.

SYMBOLIC FORM OF SYNOPTIC CODE: iii Nddff VVwwW PPPTT $N_hC_Lh C_MC_H$ T_dT_dapp 7RRR$_t$s $8N_sCh_sh_s$ $9S_pSps_ps_p$ l

STATION MODELS:

Abbreviated U. S. Model

ff
TT dd C_H / C_M PPP
VV ww (N) ±pp a
T_dT_d C_L N_h W R_t
h RR

Complete U. S. Model

ff s
TT dd C_H $[h_{85}h_{85}h_{85}\ a_3]$ / C_M PPP
VV ww (N) ±pp a
T_dT_d C_L N_h W R_t
N_s C h_sh_s / h RR
d_wd_w P_w H_w $(S_pSps_ps_p)$

NOTE In the Abridged U. S. Model the entry of s, T_xT_x, T_nT_n, $R_{24}R_{24}R_{24}R_{24}$, and Temperature Record is OPTIONAL. In some cases the specifications g

CODE FIGURES AND SYMBOLS

	C_L Clouds of type C_L	C_M Clouds of type C_M	C_H Cloud of type C_H	C Type of cloud	W Past Weather	N Total amount all clouds	a Barometer characteristic
0	No Sc, St, Cu, or Cb clouds.	No Ac, As or Ns clouds.	No Ci, Cc, or Cs clouds.	Ci	Cloud covering ½ or less of sky throughout the period.	No clouds.	Rising then falling. Now higher than, or the same as, 3 hours ago.
1	Ragged Cu, other than bad weather, or Cu with little vertical development and seemingly flattened, or both.	As, the greatest part of which is semitransparent through which the sun or moon may be faintly visible as through ground glass.	Filaments, strands, or hooks of Ci, not increasing.	Cc	Cloud covering more than ½ of sky during part of period and covering ½ or less during part of period.	One-tenth or less, but not zero.	Rising, then steady; or rising, then rising more slowly. Now higher than 3 hours ago.
2	Cu of considerable development, generally towering, with or without other Cu or Sc; bases all at same level.	As, the greatest part of which is sufficiently dense to hide the sun or moon, or Ns.	Dense Ci in patches or twisted sheaves, usually not increasing; or Ci with towers or battlements or resembling cumuliform tufts.	Cs	Cloud covering more than ½ of sky throughout the period.	Two- or three-tenths.	Rising (steady or unsteadily). Now higher than 3 hours ago.
3	Cb with tops lacking clear-cut outlines, but are clearly not fibrous, cirriform, or anvil shaped; Cu, Sc, or St may be present.	Ac (most of layer is semitransparent) other than cirrus-like or in cumuliform tufts; cloud elements change but slowly with all bases at a single level.	Ci, often anvil-shaped, derived from or associated with Cb.	Ac	Sandstorm, or dust-storm, or drifting or blowing snow.	Four-tenths.	Falling or steady, then rising; or rising then rising more rapidly. Now higher than 3 hours ago.
4	Sc formed by spreading out of Cu; Cu may be present also.	Patches of semitransparent Ac which are at one or more levels; cloud elements are continuously changing.	Ci, hook-shaped and/or filaments, spreading over the sky and generally becoming denser as a whole.	As	Fog, or thick haze.	Five-tenths.	Steady. Same as 3 hours ago.
5	Sc not formed by spreading out of Cu.	Semitransparent Ac in bands or Ac in one or more or less continuous layer gradually spreading over sky and usually thickening as a whole; the layer may be opaque or a double sheet.	Ci, often in converging bands, and Cs or Cs alone but increasing and growing denser as a whole; the continuous veil exceeds 45° above horizon.	Ns	Drizzle.	Six-tenths.	Falling, then rising. Now lower than, or the same as, 3 hours ago.
6	St in a more or less continuous layer and/or ragged shreds, but no Fs of bad weather.	Ac formed by the spreading out of Cu.	Ci, often in converging bands, and Cs or Cs alone but increasing and growing denser as a whole; the continuous veil exceeds 45° above horizon but sky not totally covered.	Sc	Rain.	Seven-or-eight-tenths.	Falling, then steady; or falling, then falling more slowly. Now lower than 3 hours ago.
7	Fs and/or Fc of bad weather (scud) usually under As and Ns.	Double-layered Ac or an opaque layer of Ac, not increasing over the sky; or Ac coexisting with As or Ns or with both.	Veil of Cs completely covering the sky.	St	Snow, or rain and snow mixed, or ice pellets (sleet).	Nine-tenths or more, but not ten-tenths.	Falling (steadily or unsteadily). Now lower than 3 hours ago.
8	Cu and Sc not formed by spreading out of Cu), base of Cu at a different level than base of Sc.	Ac with sprouts in the form of small towers or battlements or Ac having the appearance of cumuliform tufts.	Cs not increasing and not completely covering the sky.	Cu	Shower(s).	Ten-tenths.	Steady or rising, then falling; or falling, then falling more rapidly. Now lower than 3 hours ago.
9	Cb having a clearly fibrous (cirriform) top, often anvil-shaped, with or without Cu, Sc, St, or scud.	Ac, generally at several layers in a chaotic sky, dense Cirrus is usually present.	Cc alone or Cc accompanied by Ci and/or Cs, but Cc is the predominant cirriform cloud.	Cb	Thunderstorm, with or without precipitation.	Sky obscured, or cloud amount cannot be estimated.	Indicator figure. Regionally agreed elements and NOT "pp" are reported by the next two code figures.

$1d_wd_wP_wH_w$ $2h_{85}h_{85}h_{85}a_3$ $3R_{24}R_{24}R_{24}R_{24}$ $4T_xT_xT_nT_n$ (Additional Plain Language Data)

Abridged U. S. Model

ff

dd s

TT PPP

ww (N) ±pp a

T_xT_x T_nT_n RR

Temp. Record $R_{24}R_{24}R_{24}R_{24}$

U. S. GOVERNMENT PRINTING OFFICE 1955 — O—330545

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 10 cents

is given above are contractions, see the appropriate code table for full specifications.

Surface Charts

Draw isobars in black pencil at 4 mb intervals (start with 1016 mb for example).

High (H) and Low (L) pressure centers should be marked in blue and red pencil, respectively.

Use the following colors for these weather features:

Cold fronts are blue
Warm fronts are red
Stationary fronts are alternating blue/red
Occluded fronts are purple
Squall lines are blue
Surface troughs (TROF" on NCEP surface analyses) are orange

Shade in green regions where precipitation is reported.

FRONTS

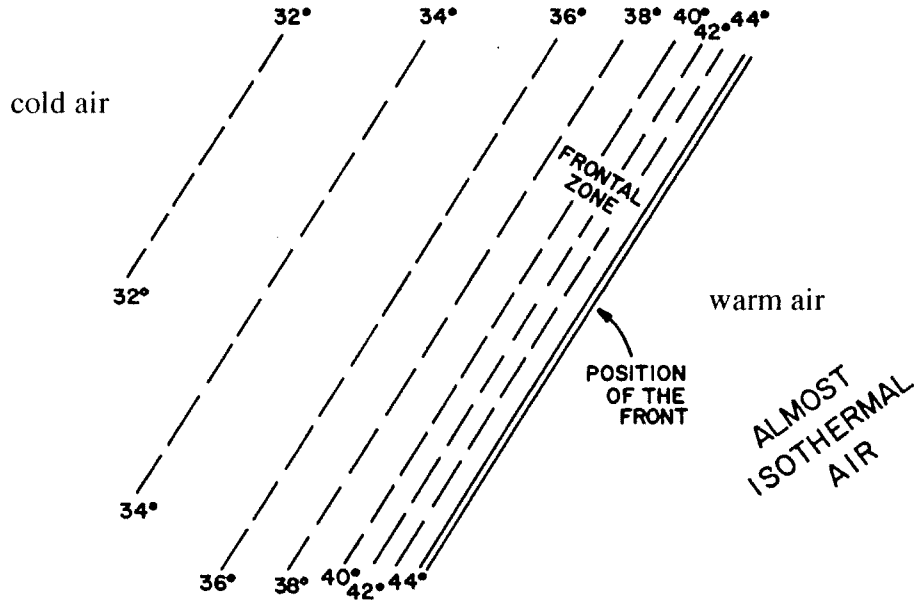
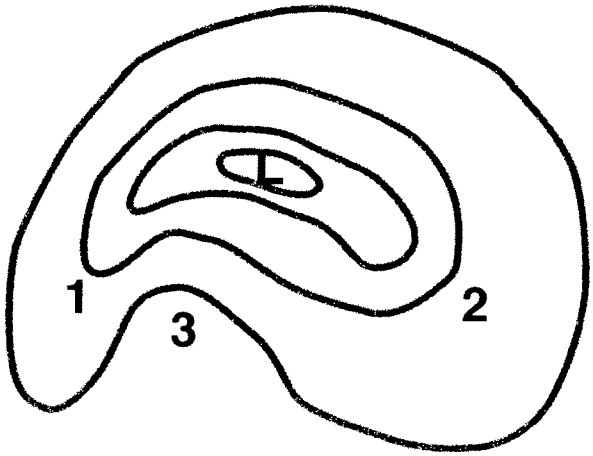


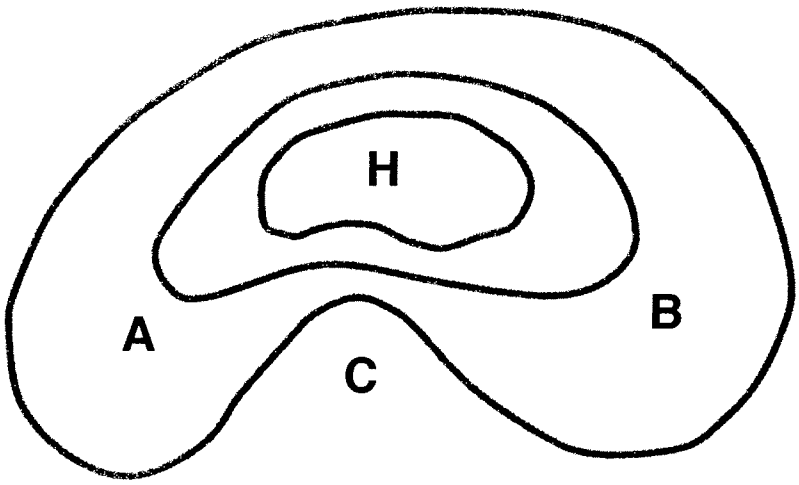
Figure 5-7

The front is located at the leading edge of the intense gradient in temperature. Dew point temperatures can also be useful. Dew points are generally lower in cold air than they are in warm air. Accordingly, there should be a drop in dew point temperature across the front.

Fronts develop in pressure troughs. The winds will shift cyclonically as you cross the front from the cold air to the warm air side. As a result, wind shifts are also a good indicator of the frontal location. Other indicators are precipitation and pressure tendency.

Finding troughs and ridges.





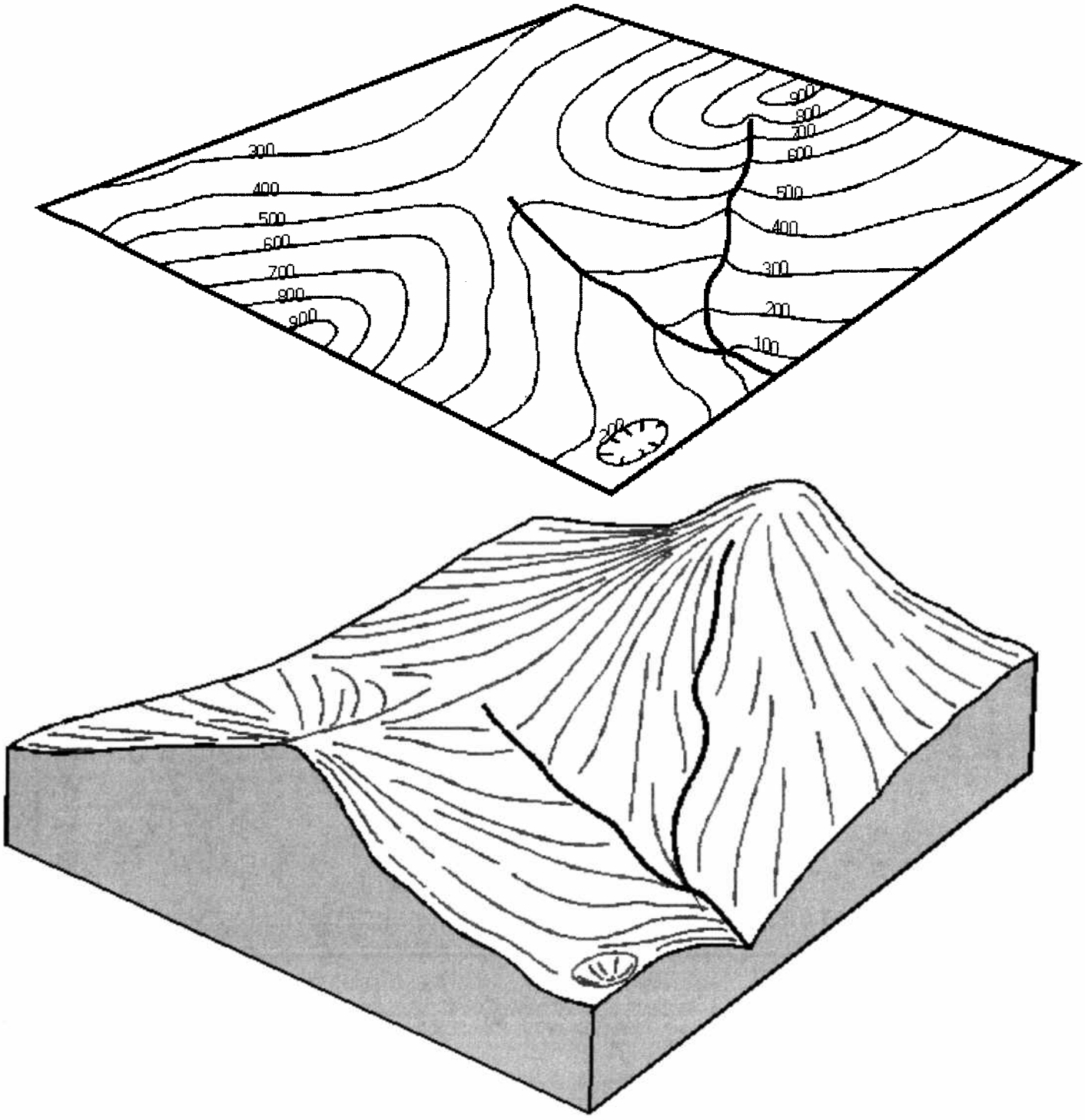
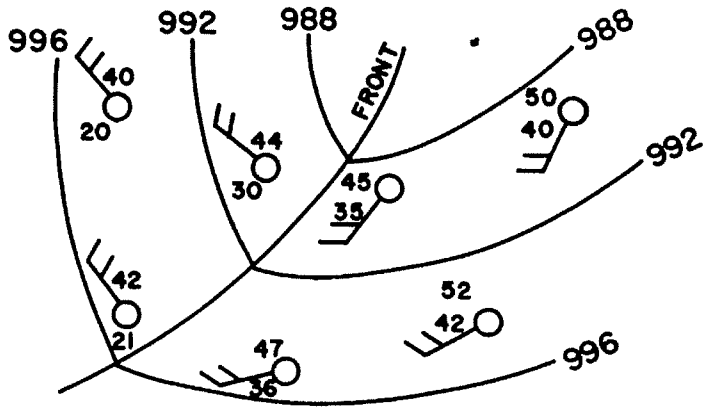
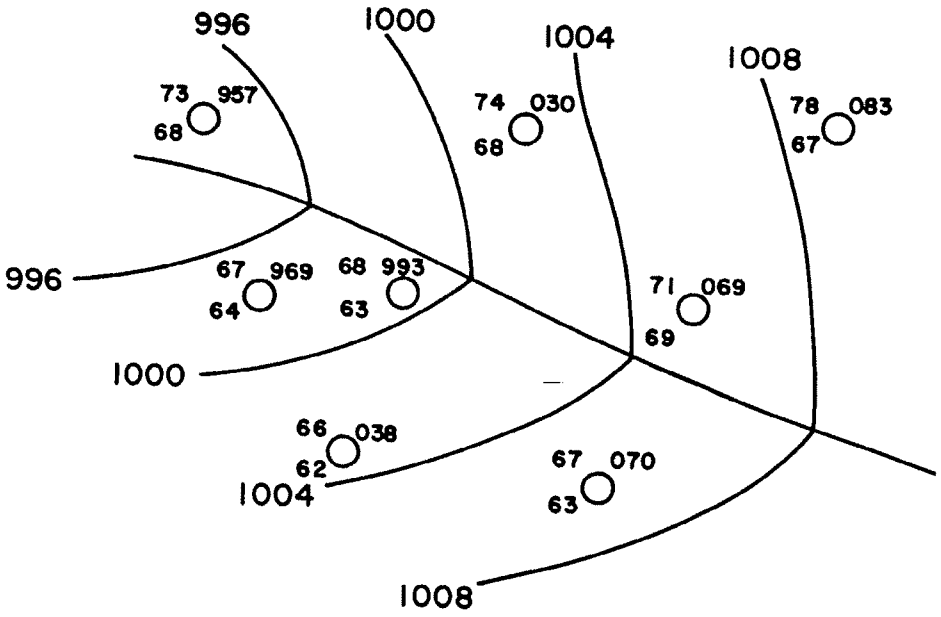


Figure 2. The relationship between a topographic map (top) and the corresponding land surface (bottom).

Weather Analysis Symbols

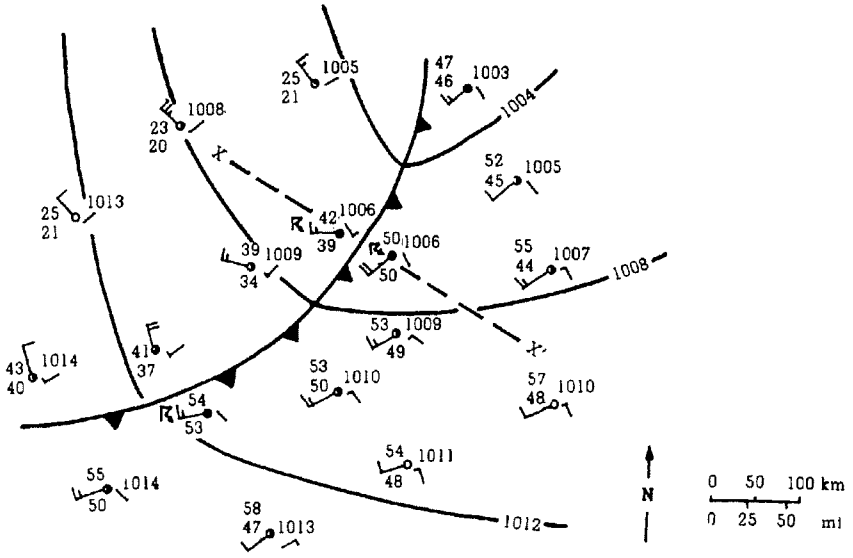
High pressure center	H	(blue)
Low pressure center	L	(red)
Cold front	▲▲▲▲	(blue)
Warm front	◗◗◗◗	(red)
Stationary front	◗▼◗▼	(alternating red/blue)
Occluded front	◗▲◗▲	(purple)
Cold frontogenesis	▲▲▲▲	(blue)
Warm frontogenesis	◗◗◗◗	(red)
Stationary frontogen.	◗▼◗▼	(alternating red/blue)
Cold frontolysis	—▲—▲	(blue)
Warm frontolysis	—◗—◗	(red)
Stationary frontol.	—◗—▼	(alternating red/blue)
Occluded frontolysis	—◗—▲	(purple)
Squall line	—••—••	(blue)
Trough(spelled"trof")	— — — —	(orange)
Tropical storm	ϕ	(red)
Hurricane	ϕ	(red)

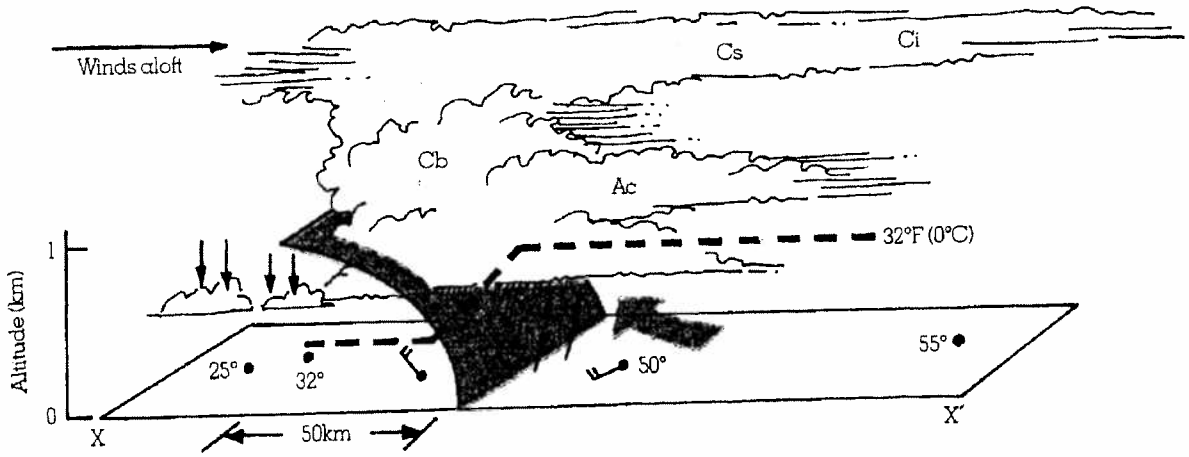




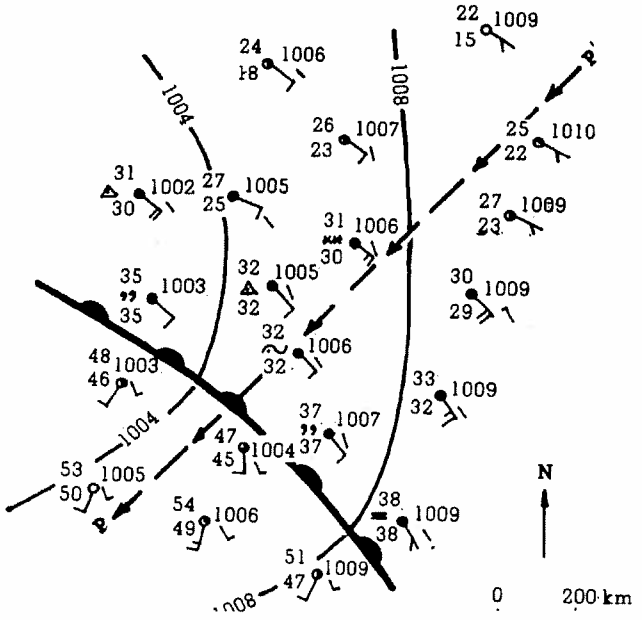
What is the wind direction? Can you tell what kind of front this is?

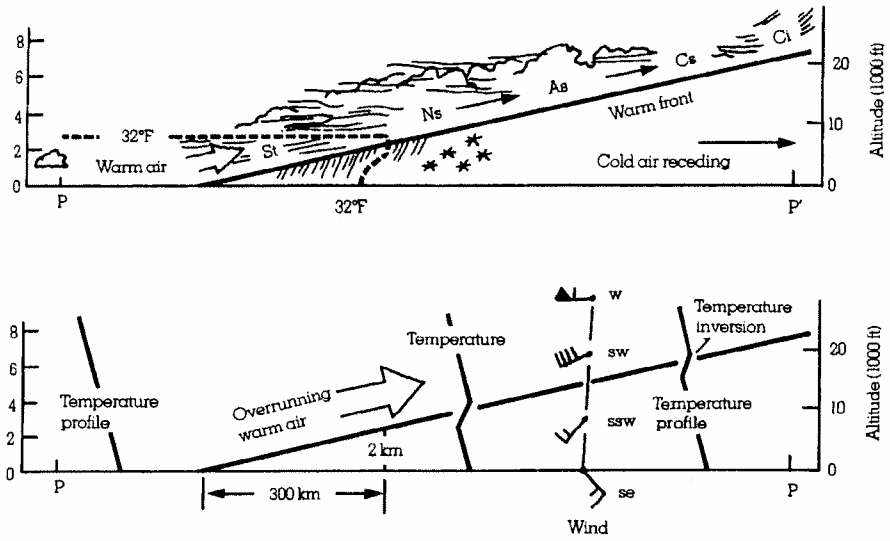
Cold front




Winds aloft
Cs
Ci
Cb
Ac
32°F (0°C)
Altitude (km)
1
0
25°
32°
50°
55°
X
X'
50km

Warm front


1004
1008
22 1009
15
24 1006
18
26 1007
23
25 1010
22
31 1002
30
27 1005
25
27 1009
23
31 1006
30
32 1005
32
35 1003
35
30 1009
29
32 1006
32
48 1003
46
33 1009
32
37 1007
37
47 1004
45
53 1005
50
54 1006
49
38 1009
38
51 1009
47
N
0
200 km



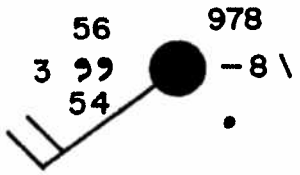
NOTE: That there is a frontal inversion for both the cold and warm fronts----frontal zones are statically stable. This can be a confusing concept since fronts are associated with precipitating weather as the moist air is forced up the front; however, the front itself is a stable region.

Current Weather Depiction

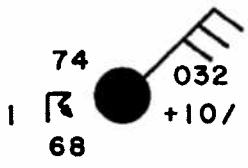
Drizzle	Rain Shower	Freezing Rain
Rain	Snow Shower (flurry)	Freezing Drizzle (heavy)
Snow	Thunderstorm	Sleet

Sky cover					
	Clear	Scattered clouds	Partly cloudy	Cloudy	Sky obscured (outer circle denotes calm wind)

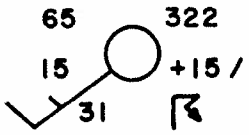
Clear < 1/10, Scattered - 1/10-5/10, Broken - 6/10-9/10, Overcast>9/10.



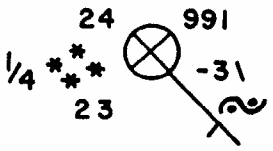
Sky cover - overcast, temperature - 56°F, dew point - 54°F, wind from the southwest at 20 kts, sea-level pressure is 997.8 mb (having fallen 0.8 mb in the last 3 hours), visibility is 3 miles in light continuous drizzle, and there has been rain in the last 6 hours.



(a)

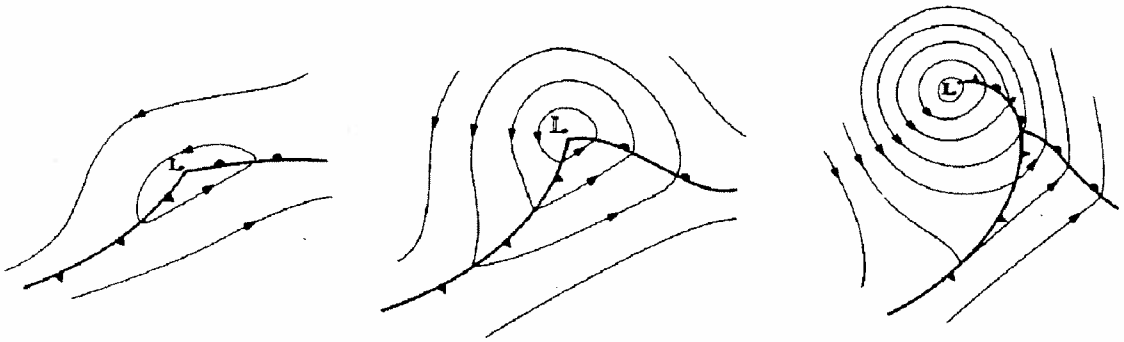


(b)

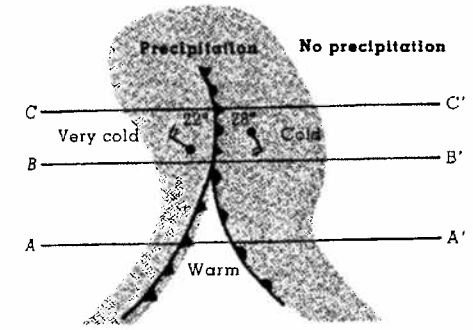


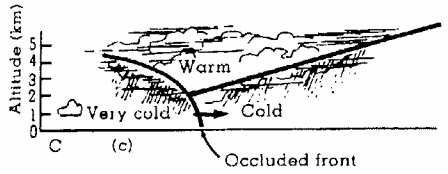
(c)

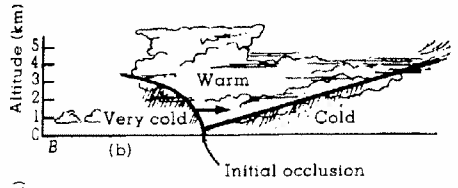
Sky Cover			
Wind Direction/ Velocity			
Temperature			
Dew Point			
Pressure (sea level)			
Pressure 3 hours ago			
Discontinuous, Continuous Fall, Rise			
Visibility			
Current Weather			
Weather in past 6 hours (if any)			

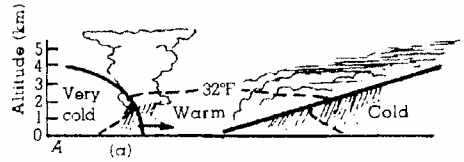


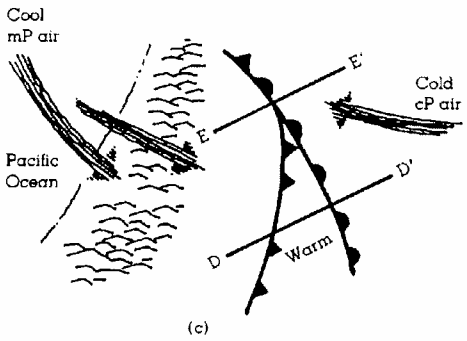
Evolving fronts within a life cycle of the extratropical cyclone.

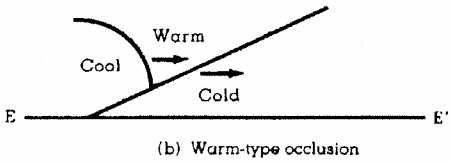




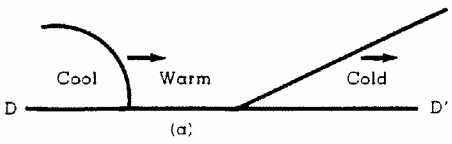




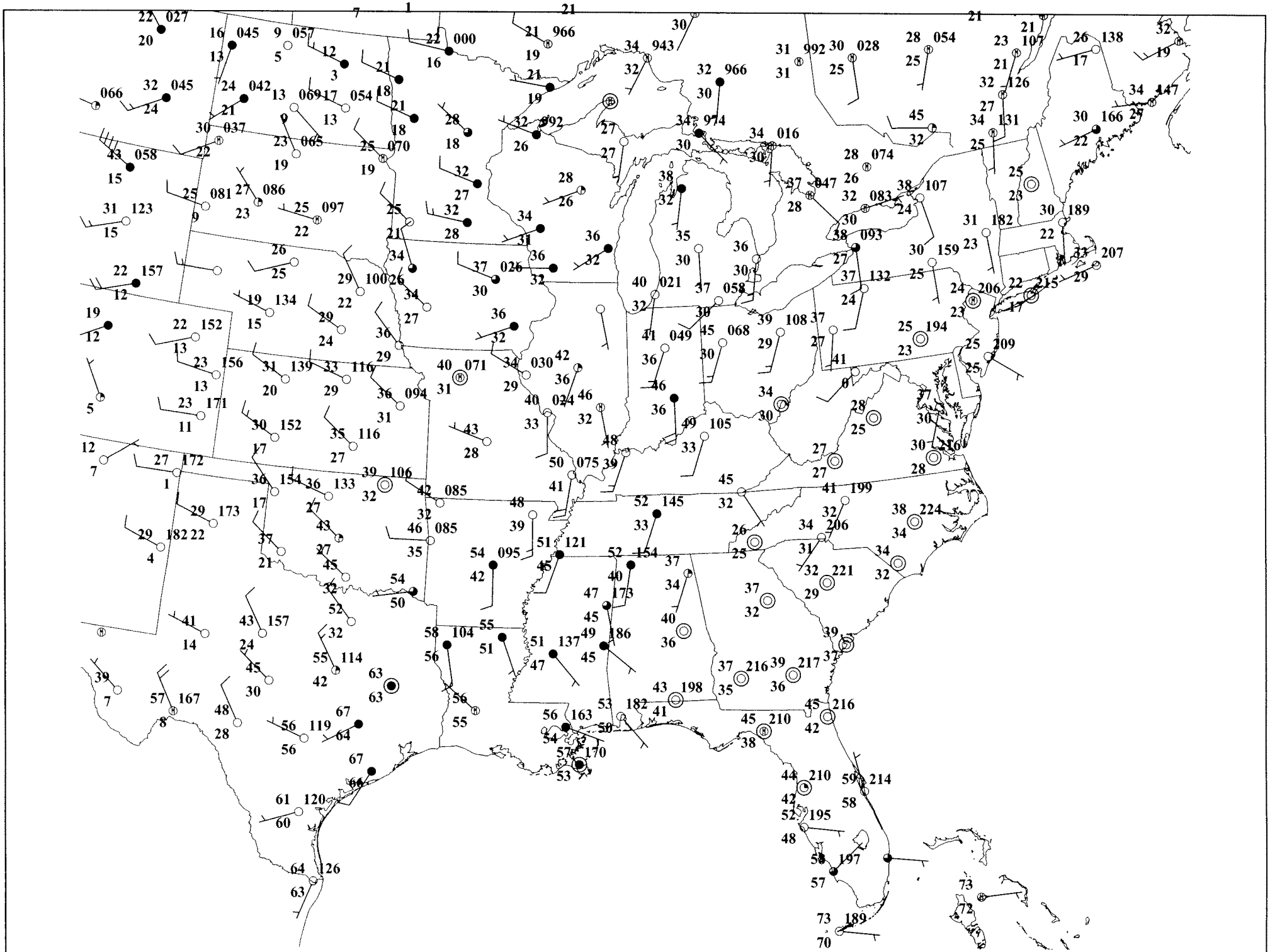




(b) Warm-type occlusion



(a)



Frontal Location Exercise