Classical Surface Analysis

Goal of weather map analysis: "After careful consideration of their representativeness and reliability, all available meteorological data must be fitted into the most probable system of ideal and modified three-dimensional tropospheric models. Analysis is a diagnosis and a synthesis of the data guided by adhering to geometrical, kinematic, dynamic and thermodynamic consistency"

From *Dynamic Meteorology and Weather Forecasting*, 1957, by C.L. Godske, T. Bergeron, J. Bjerknes, and R.C. Bundgaard, p. 651.

The following is the sequence of steps recommended by the Norwegian Bergen School for the analysis of the surface weather map:

1. Location of air masses

Warm and cold air masses are formed in source regions located away from the active storm tracks. For example, maritime tropical air masses are associated with the subtropical highs. These are warm highs which strengthen with height. Polar and arctic air masses are high pressure areas which usually form over northern continental regions due to radiational cooling and dynamical processes aloft (anticyclonic vorticity advection; cold-air advection). These cold highs weaken with height and may actually evolve into a cold low aloft. Air masses are characterized by relatively homogeneous properties but when they move from their source regions, baroclinic zones (fronts) may form at their leading edges and significant weather may result.

When a warm air mass moves poleward from its source region, it is cooled from below, thus becoming more stable with time ($\partial\theta/\partial z$ increases). It is characterized by stratiform clouds, fog and drizzle. When a cold air mass moves equatorward from its source region, it is warmed from below and is destabilized with time ($\partial\theta/\partial z$ decreases). Its leading edge (the cold front) is associated with showers and thunderstorms, followed by fair weather as the air mass center moves in.

Analysts typically use temperature, dew point temperature, visibility, cloud types, and current and past weather to locate and identify air masses. Some general guidelines have been formed to locate air mass boundaries which should be modified for local climatology. The classical rules are: that $T \geq 65$˚F, $T_d \geq 60$˚F represents tropical (maritime) air while arctic air is characterized by $T < 40$˚F, $T_d < 32$˚F.

2. Cloud and weather analysis

Overcast and clear regions are located and indicated. Cloud types and ceilings should be noted. Precipitation occurrence and type should be identified. This is done by shading areas of fog, drizzle, rain, ice pellets and snow and using symbols to indicate showers, past and current thunderstorms, dust, etc. See handouts for proper symbols and color conventions.

3. Isotherms

Analysis of surface temperature follow the basic rules of scalar analysis. Typical contour interval is 4˚F (2˚C) but should be less if the analysis region is small.

4. Isodrosotherms

Analysis of dew point temperature follows the basic rules of scalar analysis. This is a difficult analysis since moisture is harder to measure accurately and exists on smaller space scales. One obvious constraint is that $T_d \leq T$!

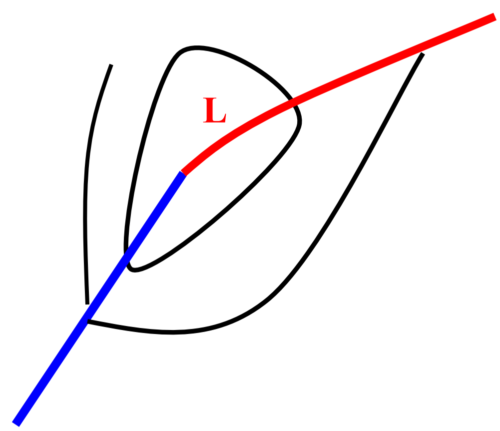
5. Isallobars

Analysis of 3-hourly pressure changes. Contour interval is typically 1mb/3h. Isallobaric rise and fall centers give a good indication of the track of surface highs and lows respectively.

6. Isobars

Analysis of the surface pressure field is the last to be completed. Contour interval is usually 2 or 4 mb depending on the size of the region. Again scalar analysis rules apply except isobars can be guided by geostrophic-gradient wind concepts modified by friction; - i.e., winds should blow across isobars toward low pressure. The intersections are generally smaller over water and for strong winds and larger over land and for weak winds. Isobars should be modified near fronts to kink toward higher pressure (or away from lower pressure.

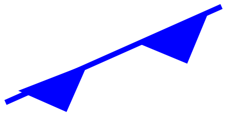
Use of wind data was not emphasized in the Bergen School due to its unrepresentativeness in rugged terrain. We shall discuss how to use the wind field when we discuss the location of fronts on the surface map.



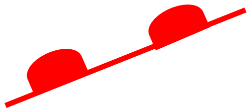
Color Conventions for Surface Analysis

FRONTS:

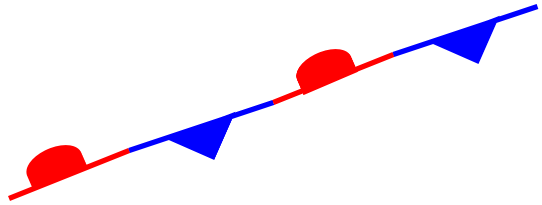
cold – blue



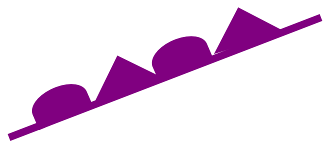
warm – red



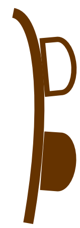
stationary – alternating red and blue



occluded – purple



dry line – brown



trough line – dashed lead pencil

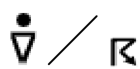
WEATHER:

fog	shade yellow
steady rain, drizzle or snow	shade green and intersperse* appropriate symbols
freezing rain or drizzle	same as above except use red shading and symbols
showers (or intermittent) rain, snow or past thunderstorms	cover affected area with appropriate symbols in green
present thunderstorms	same as above in red
dust or blowing dust	shade area light brown

NEPH ANALYSIS: Enclose overcast regions ($\geq {}^{7}/8$ sky cover) with green scalloped line.

NOTE: Shaded areas should be physically consistent with your knowledge of typical atmospheric structure; i.e., try to connect precipitation regions associated with synoptic-scale cyclones (but don't violate any data!)

* rain-snow line is dashed green

	COLD FRONT		WARM FRONT	
VARIABLE	**Before Passage**	**After Passage**	**Before Passage**	**After Passage**
Clouds	TCU, Cb, Sc, Ns (convective)	Fast moving: convection; rapid clearing Slow moving: Stratus; slow clearing	Low stratiform near front Ci→Cs→As→Ns	Clearing; widely scattered convection
Pressure tendency	Falling steadily	Rapid rise	Falling	Fairly steady
Temperature	High, peaking near front	Falling – may be gradual or rapid depending on frontal character	Rising	High – fairly uniform (steady)
Dewpoint	Relatively high	Decreasing rapidly	Increasing as front approaches $T_d \approx T$ near front	High – fairly uniform (steady)
Wind direction	SE to SW, veering to parallel at front	NW	E-SE	S-SW
Precipitation	 Just ahead of and with passage	Rapid end (fast moving) continuous for several hours (slow moving)	Steady continuous precip. up to 300 mi ahead of front	Scattered convection
Visibility	Lowering	Fast moving-rapid improvement Slow moving-continous low visibility with gradual improvement	Lowering rapidly in precipitation	Improvement
Ceiling	Lowering	″	″	Rising