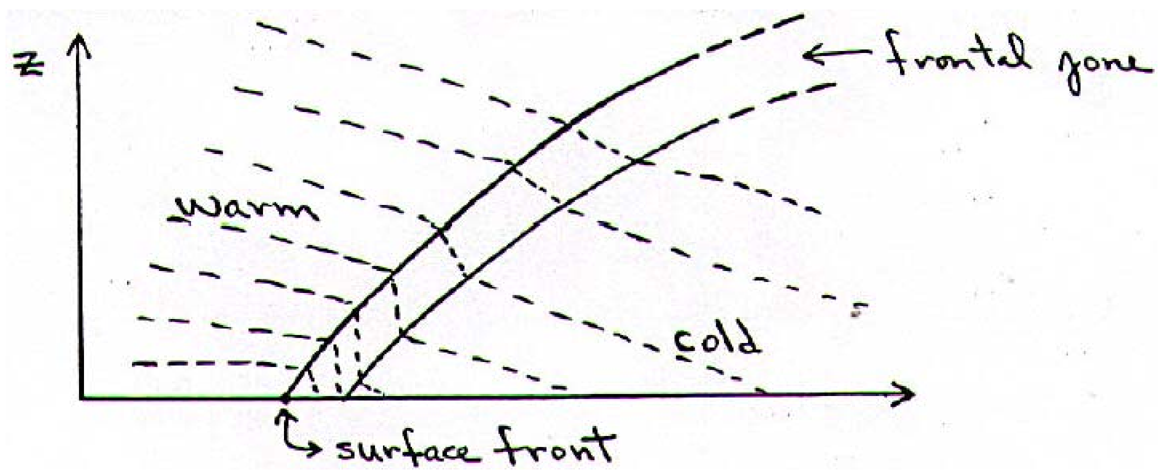
Surface Fronts

Surface fronts are boundaries between two different air masses. They are usually found on the warm air side of the leading edge of a migrating air mass and play an intimate role in cyclogenesis and cyclone structure. Fronts are generally regions of strong temperature gradients and confluence in the wind field. The primary temperature contrast occurs in the frontal or baroclinic zone on the cold air side of the front. Please read Wallace and Hobbs, p. 114-121 for details of frontal characteristics.

The basic structure of a front is best shown using isotherms in a vertical cross section:

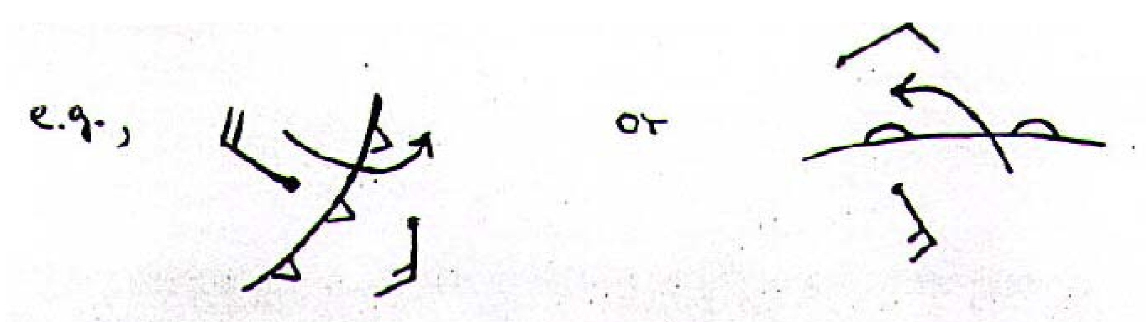


Note that you can not ascertain from this diagram alone if it is a warm, cold or stationary front. The frontal type depends on the direction the front is moving (although the frontal slope and vertical motion distribution would evolve differently between cold and warm fronts).

Location of fronts in surface analysis.

1. Wind

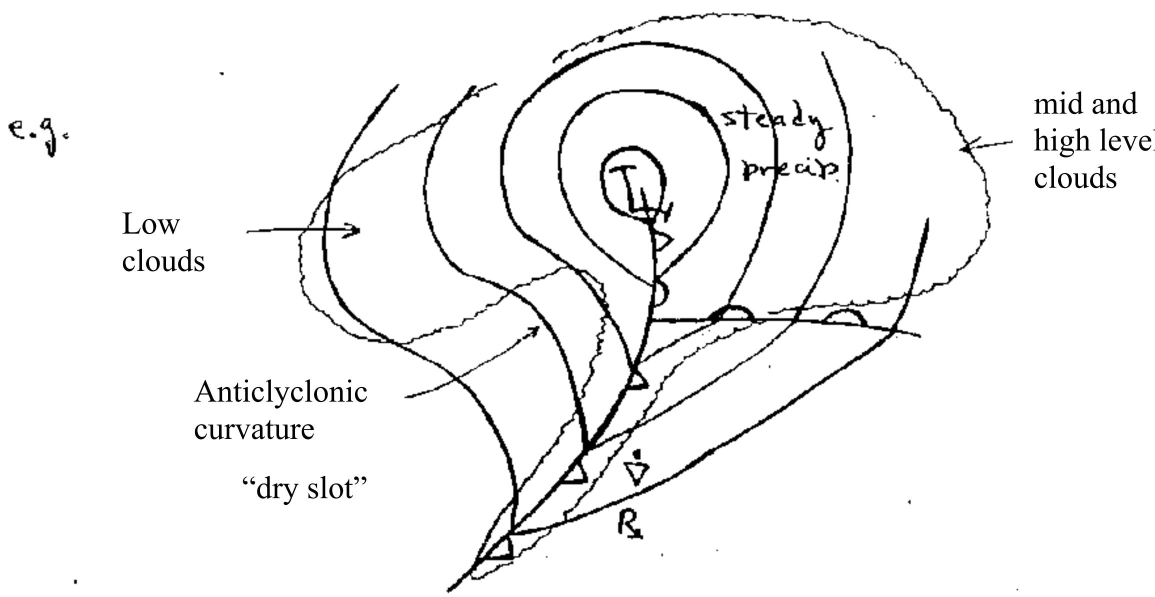
A front is a zone of confluence; therefore we experience a wind shift across the front. As you move in the direction of the front, the wind shifts cyclonically.



Plotting a time series of wind (and other surface parameters) is a very useful technique for identifying times of frontal passage (see W&H, p. 123-125). For strong fronts, the wind shift is quickly followed by a rapid temperature change but for weaker fronts or over oceans or at the southern extension of a deeply penetrating cold front, the baroclinic zone may be evenly spread out or be located behind the wind shift by several hundred km. Since winds are often dominated by local effects such as valleys, mountains, coasts, etc., one should take the local topography into account when locating fronts.

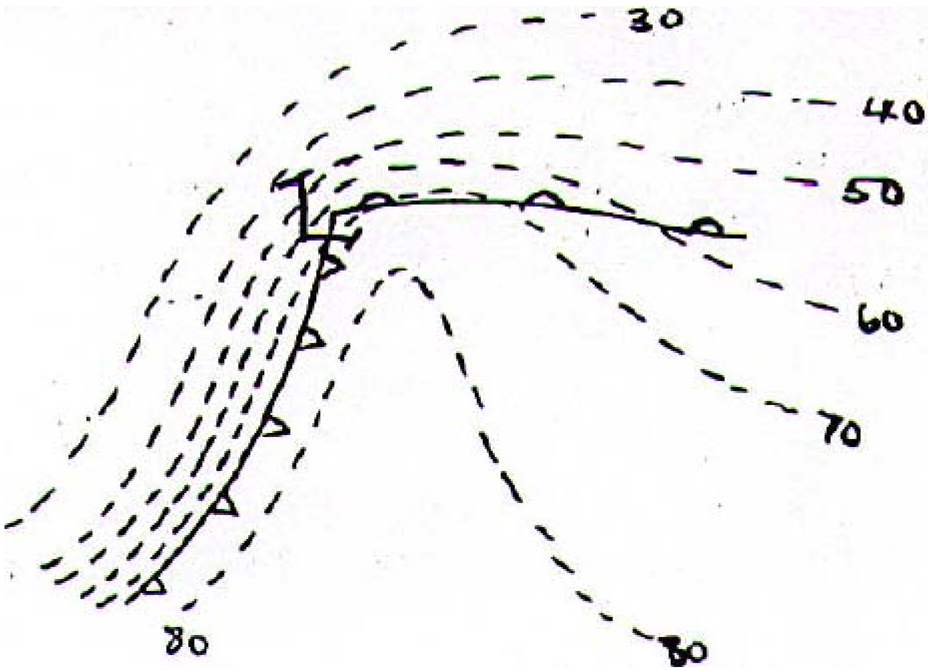
2. Pressure

Fronts are located in pressure troughs, i.e., - where cyclonic curvature and vorticity are strongest. In your synoptic lecture course, you will learn quantitatively why isobars kink away from low pressure at the front; therefore you must do this even if the data is not dense enough to show it. Recall that because of the balance of forces at the surface, the curvature of the isobars is highly correlated to the observed weather. Because friction causes surface winds around a low to cross isobars toward the low center, convergence, upward vertical motion and clouds will exist. Surface winds around an anticyclone cross isobars away from the high center, causing surface divergence and sinking air above, leading to clearing skies. Therefore your analysis of isobars and fronts should correspond with the cloud distribution seen in satellite imagery.



3. Temperature

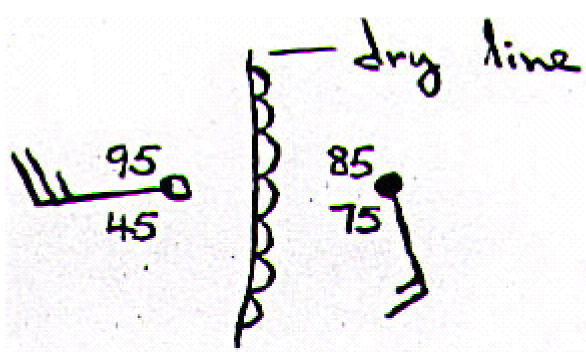
The front is located on the warm side of the temperature gradient. Note that the warmest air in a cyclone-anticyclonic couplet is just ahead of the cold front (which makes sense because this is the air that has been heated the longest since the last frontal passage). Therefore the cold front will border a northward extending warm tongue.



Note also that the temperature gradient behind the cold front is usually more intense than that ahead of a warm front. This is related to the steeper slope of the cold front and the greater downward transport of cold air in the unstable air.

4. Dew point

Dew point temperatures are generally lower in continental air and, of course, in colder air. Dew points may be useful in locating warm fronts. They are of primary importance in locating dry lines which may be located like a cold front with respect to a low but, owing to diurnal heating and mixing, have warmer temperatures on the west side of the boundary.



5. Pressure tendency

In principle, we should see pressure falls ahead of warm and cold fronts and pressure rises behind. For hydrostatic reasons, falls are most noticeable north of the warm front as the warm air becomes deeper. Rises most prominent behind cold fronts as the denser air rushes in. A “check tendency” (✓) in the station plot may indicated a frontal passage.

Pressure tendencies should be adjusted for diurnal pressure changes caused by tides in the upper atmosphere. These tides vary with location and season and have greater amplitude in southern than in northern regions. For Oklahoma, the maxima are at 10 am and 10 pm while the minima occur at 4 am and pm. The amplitude is around 1-2 mb.