# Fronts

**Front:** a narrow zone of transition between air masses of contrasting density, that is, air masses of different temperatures or different water vapor concentrations or both.

Named by the air mass that is advancing

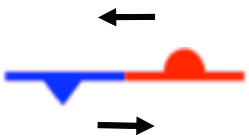
Origin of word inspired from end of World War I by Tor Bergeron, who also invented the frontal cycle. He mockingly described the transition zone as battle lines of advancing and retreating air masses.

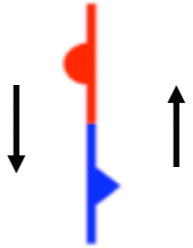
Four types of fronts: cold front, warm front, occluded front, and stationary front.

Wind shift is always cyclonic

**<u>Stationary front:</u>** a nearly stationary narrow zone of transition between contrasting air masses;

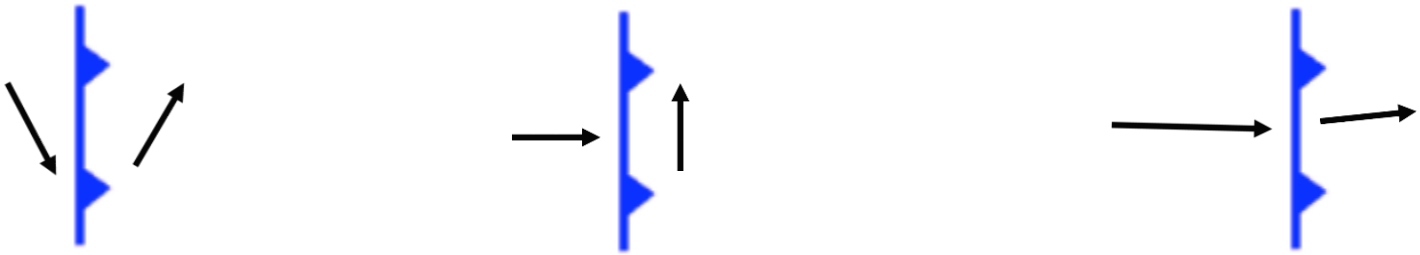
- winds blow parallel to the front but in opposite directions on the two sides of the front
- sometimes associated with a wide region of clouds or precipitation on the cold side of the front.
- Below are some possible wind patterns





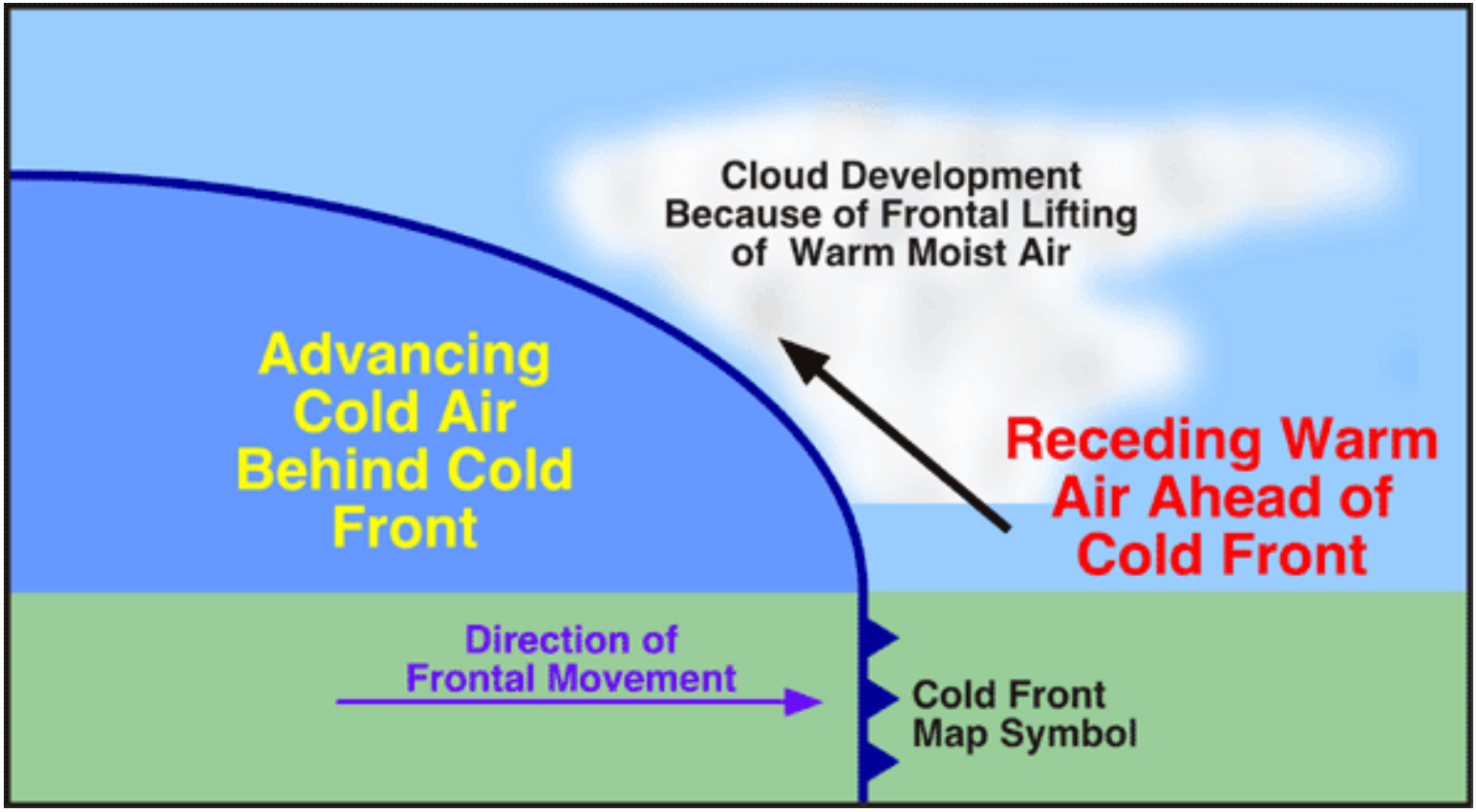
**<u>Cold front:</u>** a narrow zone of transition between advancing relatively cold (dense) air and retreating relatively warm (less dense) air.

- Often associated with a sharp temperature drop and reduction in dewpoint in winter
- Mathematically, the cross-front velocity is from cold air to warm air
- Moves faster than a warm front
- Blue triangles point in way of movement
- Below are some possible wind patterns. Any pattern with a cyclonic shift and the net wind vector pointing from cold to warm air is valid



## Some of the characteristics of cold fronts include the following:

- steep slope
- faster movement / propogation than other fronts
- most violent weather among types of fronts
- move farthest while maintaining intensity
- tend to be associated with cirrus well ahead of the front, strong thunderstorms along and ahead of the front, and a broad area of clouds immediately behind the front (although fast moving fronts may be mostly clear behind the front).
- can be associated with squall lines (a line of strong thunderstorms parallel to and ahead of the front).
- usually bring cooler weather, clearing skies, and a sharp change in wind direction.




The slope of a cold front is steeper (1:50 to 1:100) than the slope of a warm front (1:150)

# General weather characteristics of a cold front
# Many exceptions

| Weather Feature | Before frontal passage | Region of front | After frontal passage |
|---|---|---|---|
| **Winds** | SE to SW | gusty | W to NW |
| **Temperature** | warm | sudden decrease | steady cooling |
| **Dew point** | high | steady | decreases steadily |
| **Pressure** | falling steadily | minimum; rapid rise | steady rise |
| **Visibility** | fair to poor | poor then improving | good |
| **Clouds** | Ci, Cs, Cb | Cb | Cu |
| **Precip** | showers | heavy precip | clearing |

**Warm front:** a narrow zone of transition between advancing relatively warm (less dense) air and retreating relatively cold (dense) air.

- warm front is sometimes associated with a broad cloud and precipitation shield that may extent hundred of kilometers ahead of the surface front

•Mathematically, the cross-front velocity is from warm air to cold air

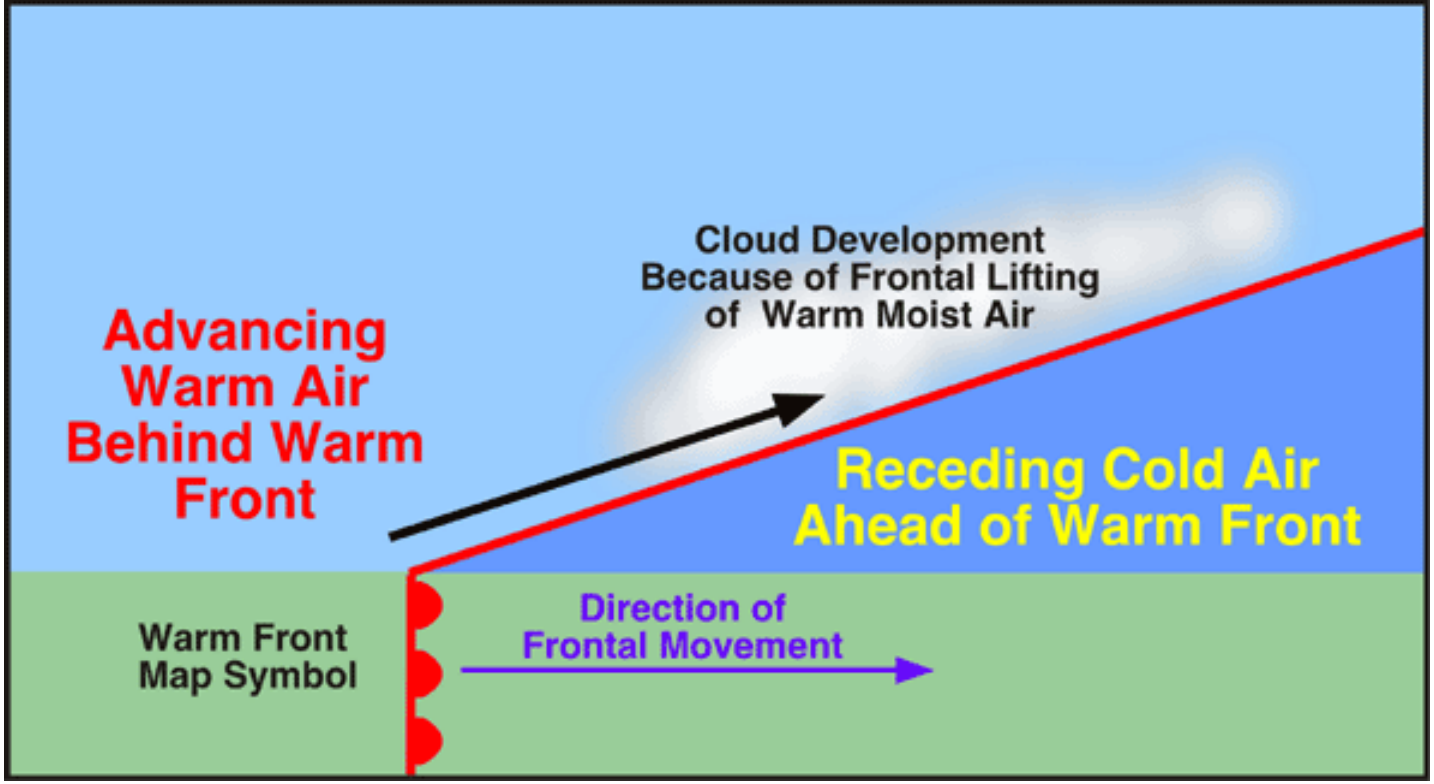
• Moves slower than a cold front

• Red semi-circles triangles point in way of movement

• Below are some possible wind patterns. Any pattern with a cyclonic shift and the net wind vector pointing from warm to cold air is valid

**Some of the characteristics of warm fronts include the following:**

- slope of a typical warm front is more gentle than cold fronts
- tend to move slowly.
- are typically less violent than cold fronts.
- although they can trigger thunderstorms, warm fronts are more likely to be associated with large regions of gentle ascent (stratiform clouds and light to moderate continuous rain).
- are usually preceded by cirrus first (1000 km ahead), then altostratus or altocumulus (500 km ahead), then stratus and possibly fog.
- behind the warm front, skies are relatively clear (but change gradually)



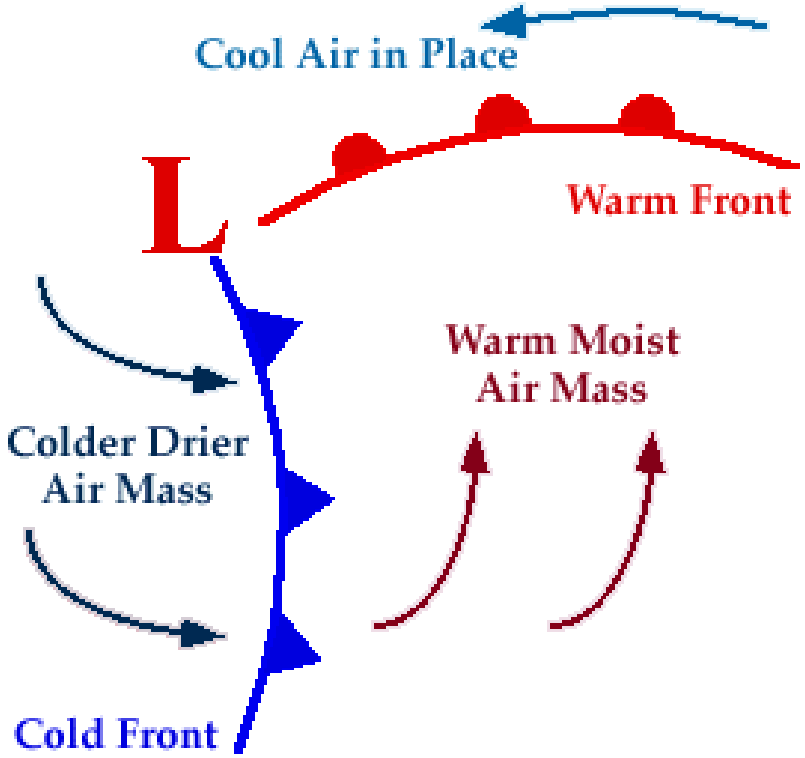

The type of frontal weather depends on the stability of the warmer air:

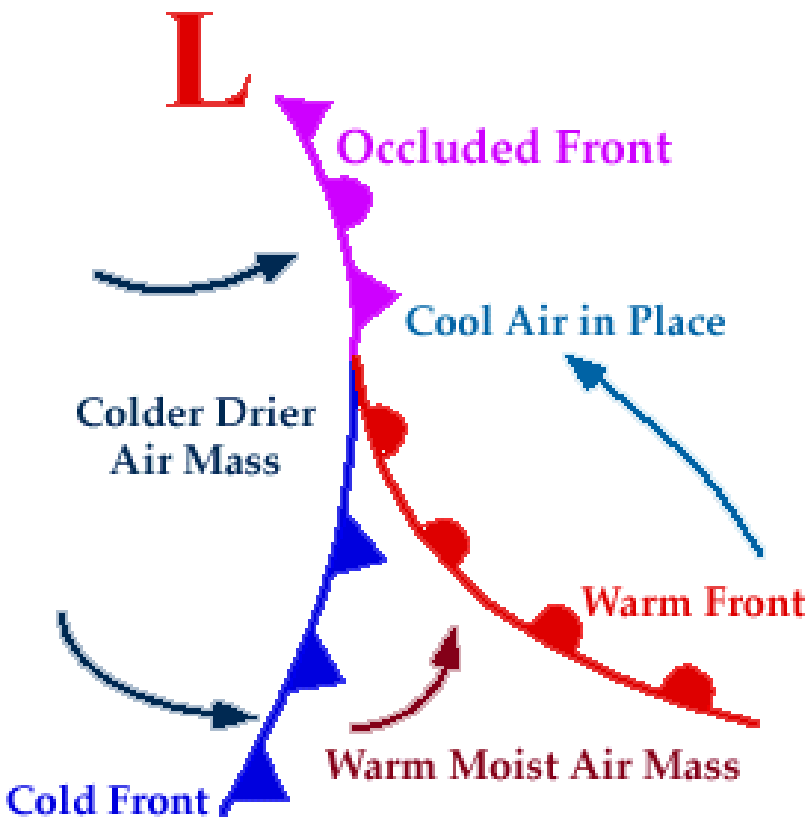
- when warm air is stable, a *frontal inversion* may exist in the upper frontal region, a steady light-to-moderate rainfall or *frontal fog* is observed in the presence of nimbostratus or stratus clouds, respectively.
- when the warm air is unstable, brief periods of heavy rainfall are observed in the presence of cumulonimbus clouds.

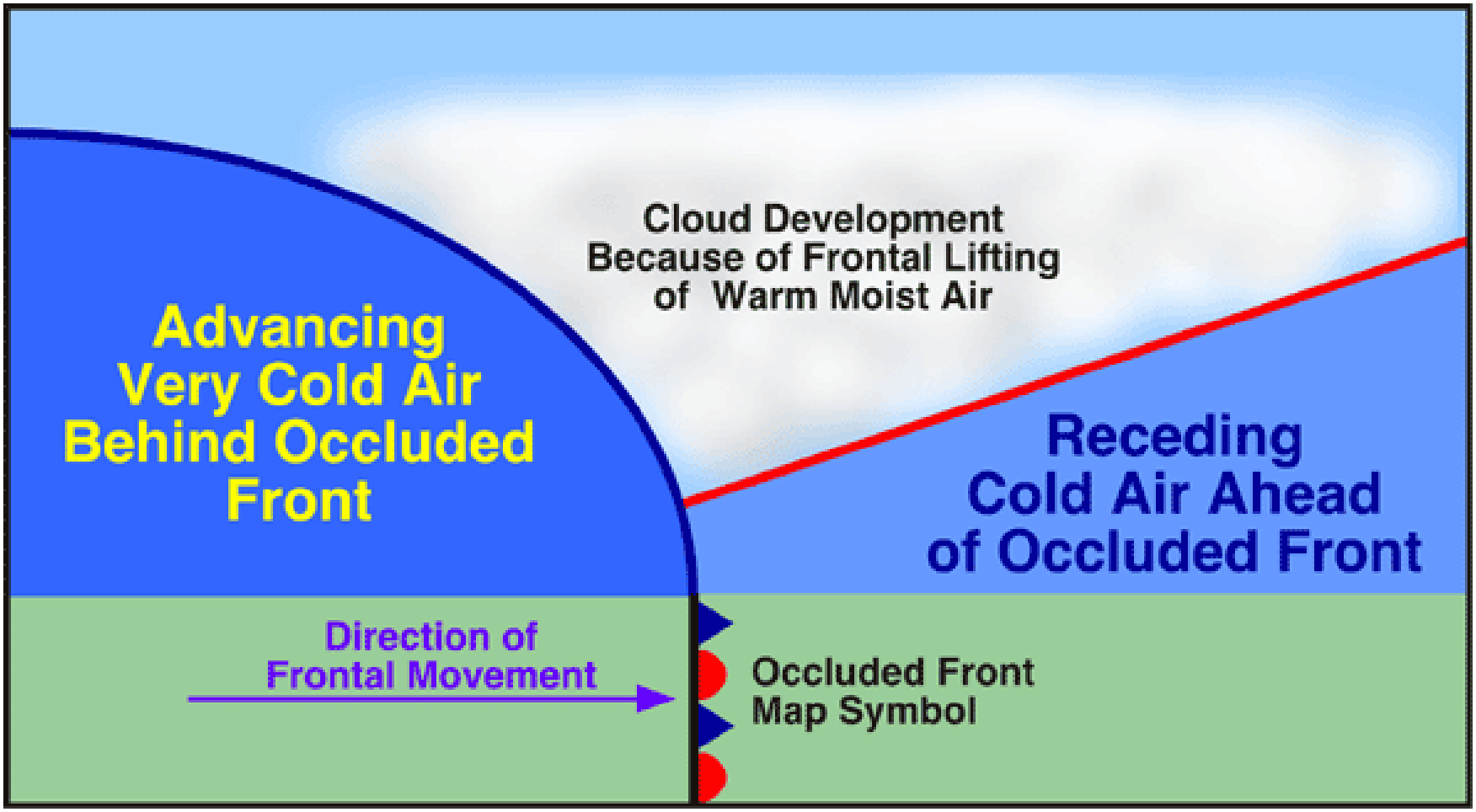
# General weather characteristics of a warm front
# There are still exceptions, but is a more consistent pattern than cold fronts

| Weather Feature | Before frontal passage | Region of front | After frontal passage |
|---|---|---|---|
| **Winds** | NE to E | variable | S to SE |
| **Temperature** | cool, slowly warming | steady rise | warmer |
| **Dew point** | steady rise | steady | increases, then steady |
| **Pressure** | usually falling | levels off | slight rise, followed by fall |
| **Visibility** | Poor, sometimes fog | improving | fair |
| **Clouds** | Ci, Cs, As, Ns, St, fog | stratus | Clearing with scattered Sc |
| **Precip** | light to moderate, can be SN or RA | drizzle or nothing | usually none |

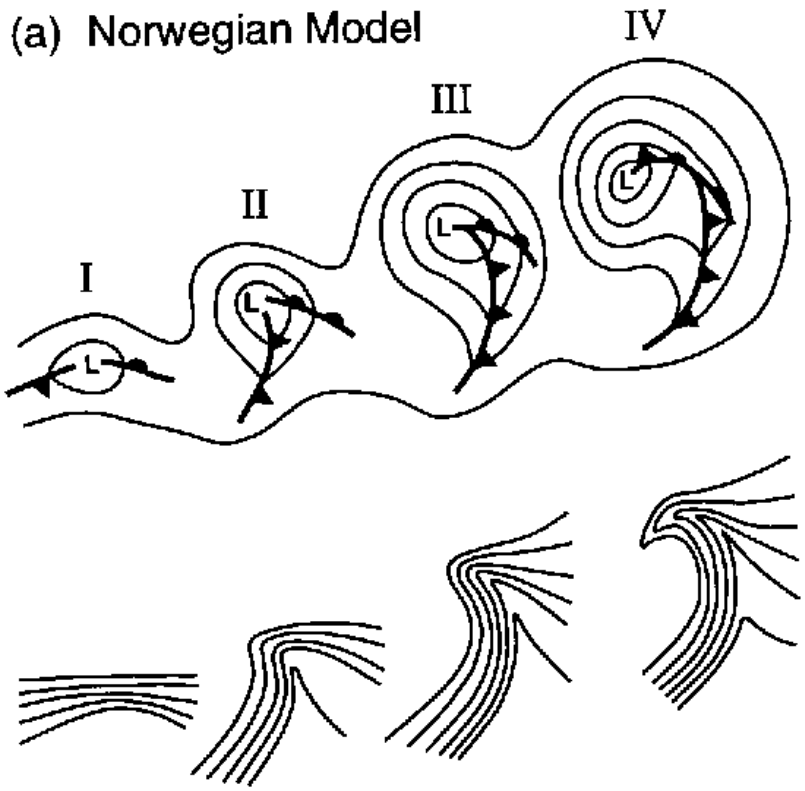
**Occluded front (occlusion):** a narrow zone of transition formed when a cold front overtakes a warm front.

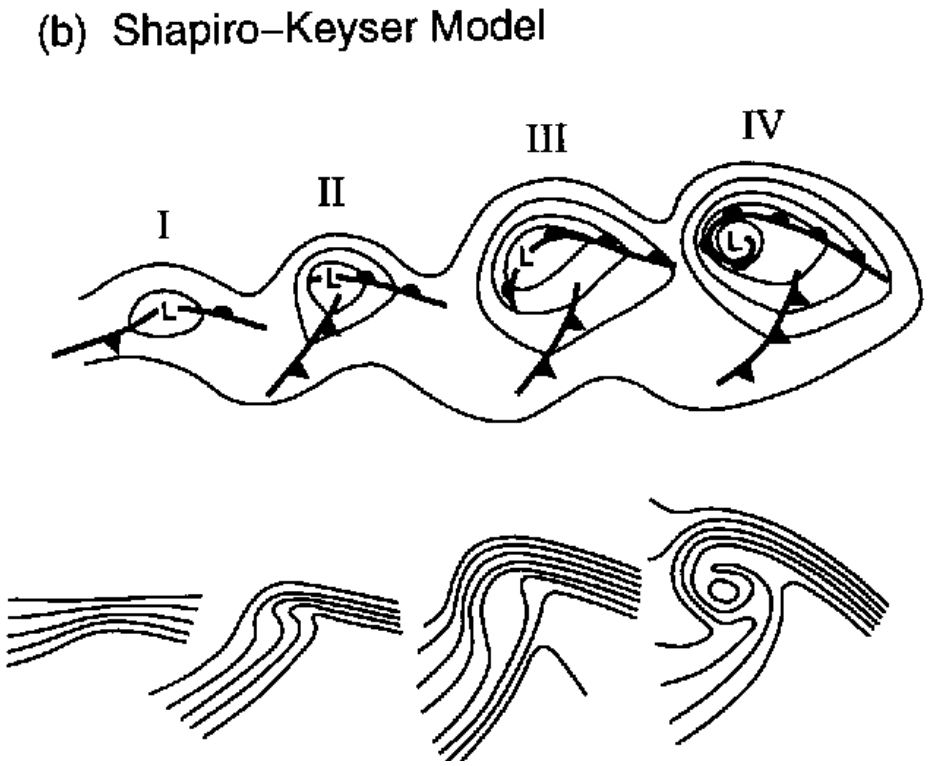



Cloud Development
Because of Frontal Lifting
of Warm Moist Air
Advancing
Very Cold Air
Behind Occluded
Front
Receding
Cold Air Ahead
of Occluded Front
Direction of
Frontal Movement
Occluded Front
Map Symbol

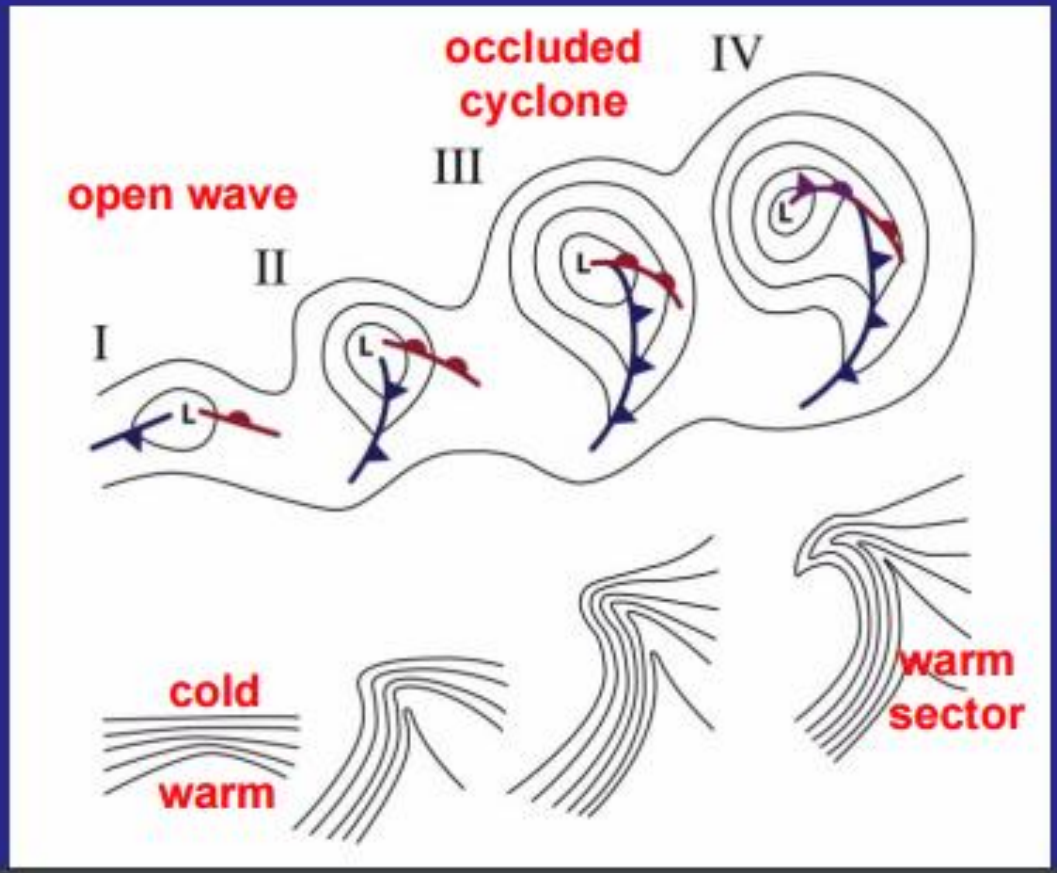
# Stages of mid-latitude cyclone development: Two models of development




Occurs over ocean. Cold front separates from and then moves perpendicular to the warm front, and never catches up. Strong arm-sector winds carry warm front around low, causing a “back-bent” front

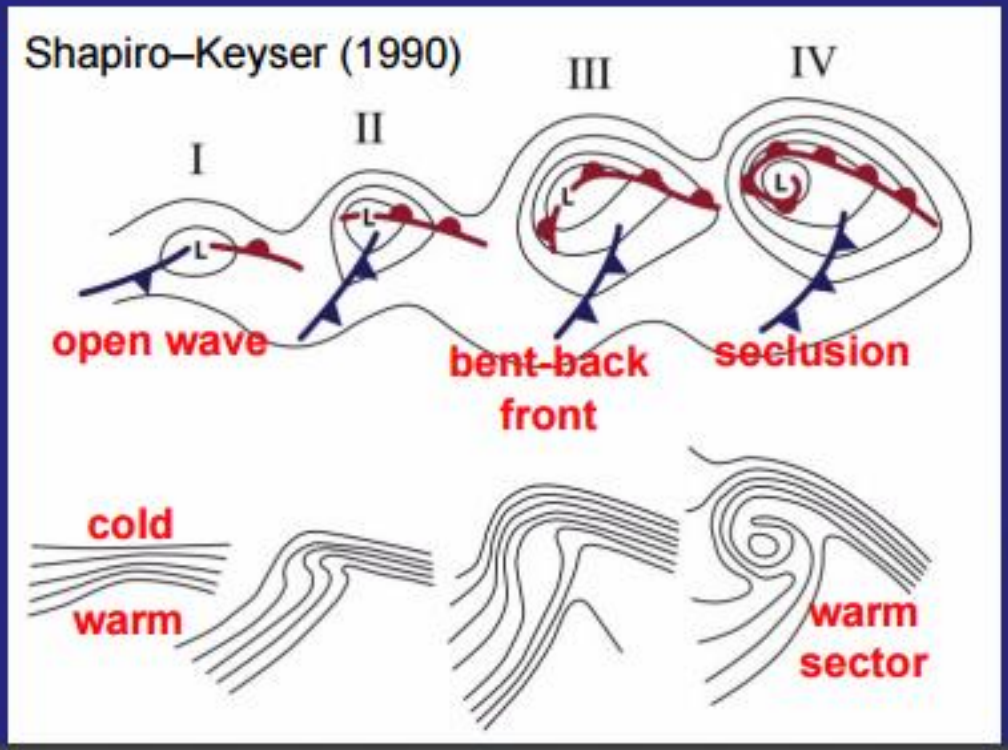
# Norwegian cyclone model



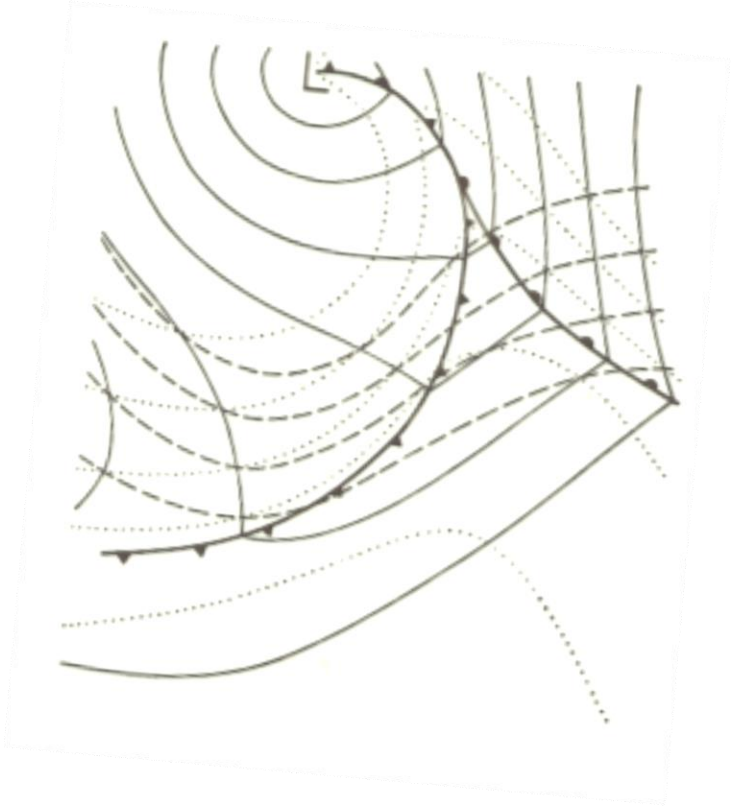

isobars

isotherms

# Shapiro–Keyser cyclone model



# Typical isobar (solid line) and temperature pattern (dashed)



Note the temperature gradient is poleward of the cold and warm front