The Course of

Atmospheric forecasting

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ATMOSPHERIC SCIENCES DEPARTMENT

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THERID STAGE

Fronts, Formation, Identification and Frontal Weather

Contents

- Fronts
- Formation
- Identification and Frontal Weather

Fronts

- Fronts are boundary surfaces that separate air masses of different densities one of which is usually warmer and contains more moisture than the other.
- The zones that Separate the vast sizes of air masses.
- A front is the transition zone between two air masses of different densities.
- Separate air masses with contrasting temperatures. Often, they separate air masse s with different humidity's as well called Fronts.
- Fronts can form between any two contrasting air masses.

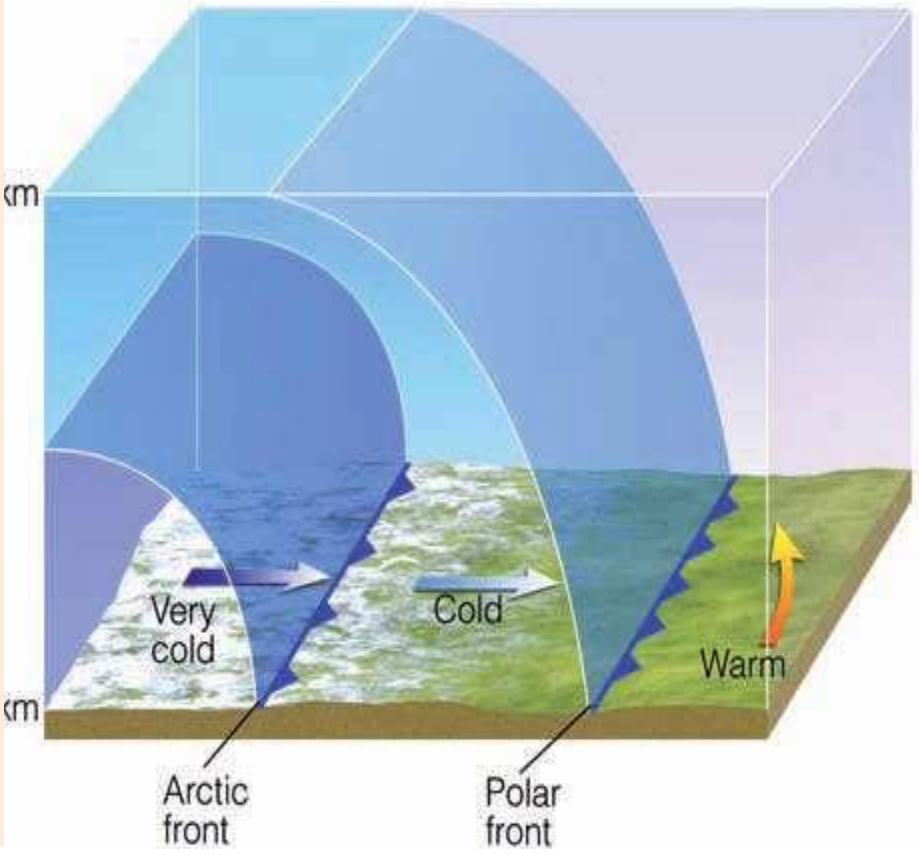
Fronts

- الجبهات عبارة عن أسطح حدودية تفصل الكتل الهوائية ذات الكثافات المختلفة والتي عادة ما تكون أكثر دفئًا وتحتوي على رطوبة أكثر من الأخرى.
- المناطق التي تفصل الأحجام الهائلة للكتل الهوائية.
- الجبهة هي المنطقة الانتقالية بين كتلتي هواء بكثافات مختلفة.
- فصل الكتل الهوائية بدرجات حرارة متناقضة. في كثير من الأحيان ، يفصلون مجموعات الهواء مع الرطوبة المختلفة وكذلك تسمى الجبهات.
- يمكن أن تتكون الجبهات بين أي كتلتي هواء متباينتين.

Frontal Surface or Frontal Zone

The upward extension of a front is referred to as a frontal surface or front al zone.

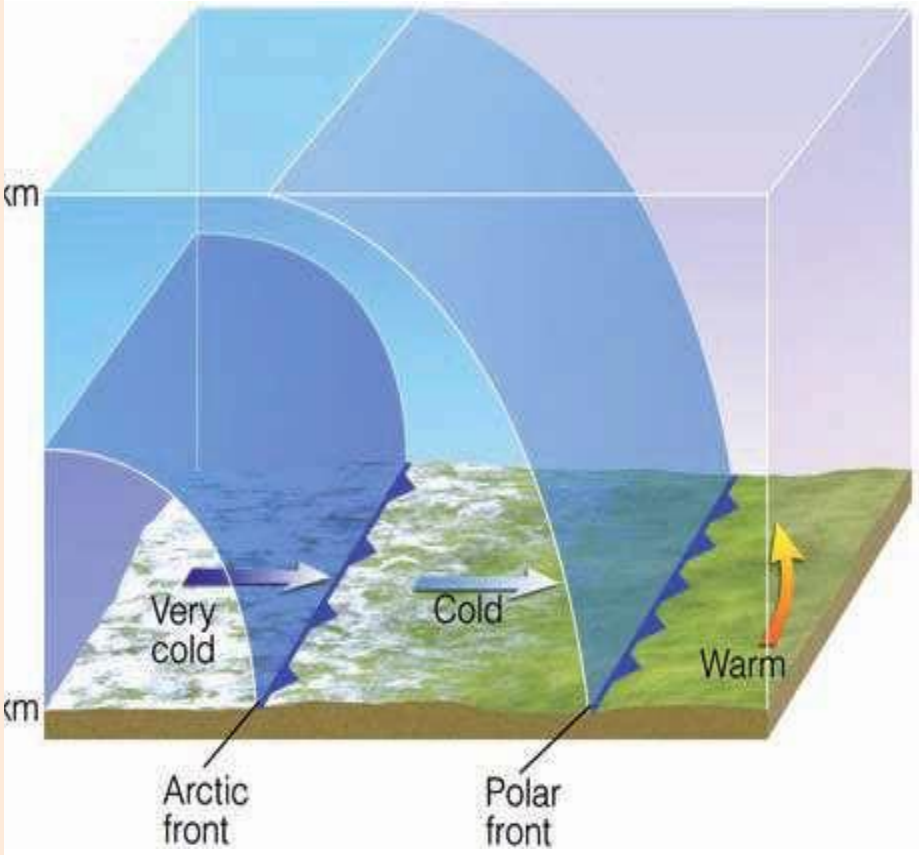
Frequently, two air masses, especially in the middle latitudes, develop a sharp boundary or interface, where the temperature difference between them becomes intensified. Such an area of intensification is called a **frontal zone** or a **front**. The boundary between the warm and cold air masses always slopes upwards over the cold air. This is due to the fact that cold air is much denser than warm air. The sloping of warm air over the cold air leads to a forced uplifting (**frontal lifting**) of the warm air if one air mass is moving toward the other. In turn, this uplifting causes condensation to occur and the possibility of precipitation along the frontal boundary.



Frontal Surface or Frontal Zone

The upward extension of a front is referred to as a frontal surface or front al zone.

في كثير من الأحيان ، تقوم كتلتان هوائيتان ، خاصة في خطوط العرض الوسطى ، بتطوير حدود أو واجهة حادة ، حيث يصبح فرق درجة الحرارة بينهما مكثفًا. تسمى منطقة التكثيف هذه منطقة أمامية أو جبهة. دائمًا ما ينحدر الحد الفاصل بين كتل الهواء الدافئ والبارد لأعلى فوق الهواء البارد. ويرجع ذلك إلى حقيقة أن الهواء البارد أكثر كثافة من الهواء الدافئ. يؤدي انحدار الهواء الدافئ فوق الهواء البارد إلى الرفع القسري (الرفع الأمامي) للهواء الدافئ إذا كانت إحدى الكتل الهوائية تتحرك نحو الأخرى. في المقابل ، يتسبب هذا الرفع في حدوث التكثيف وإمكانية هطول الأمطار على طول الحدود الأمامية.

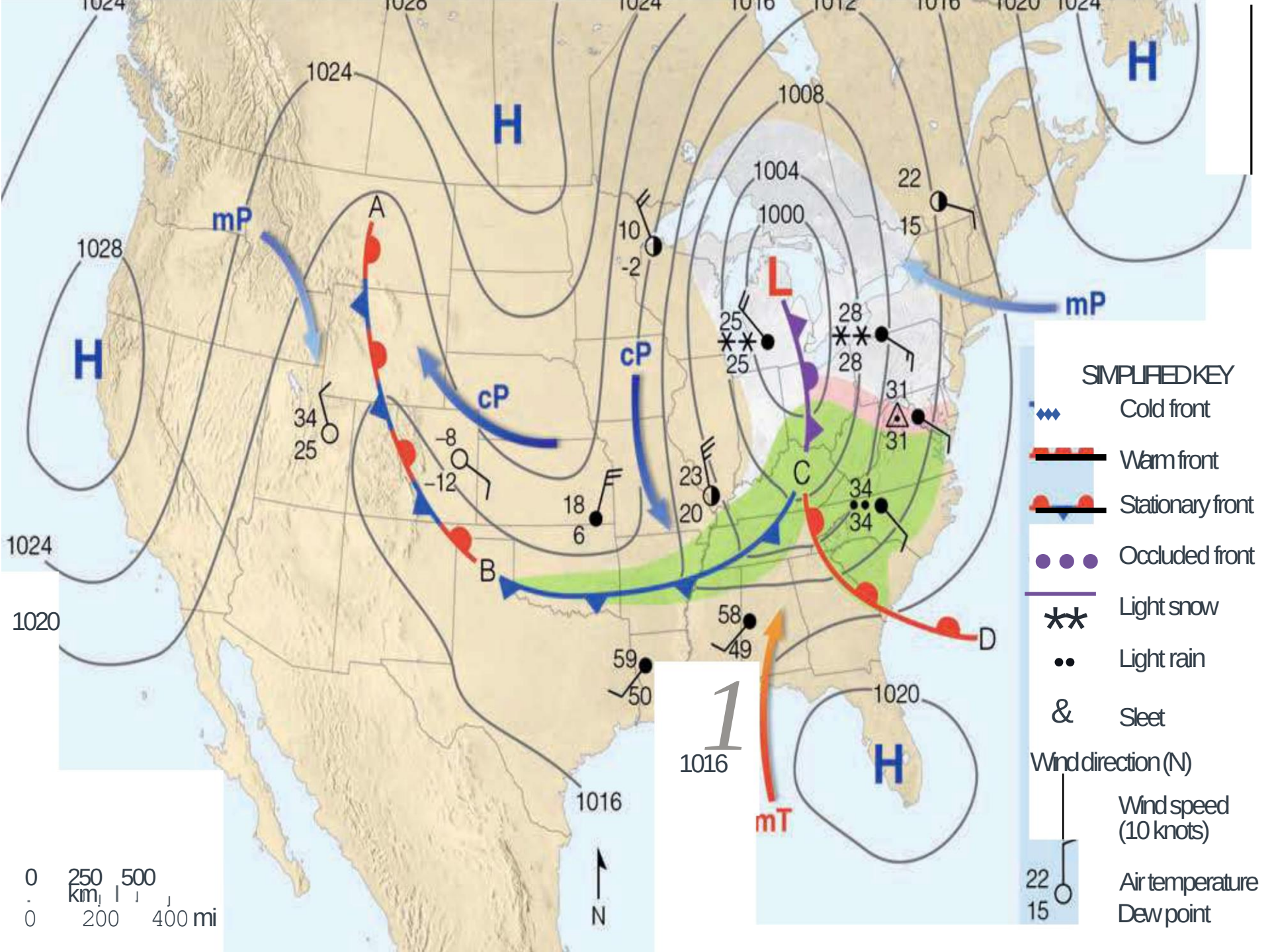


Formation of Fronts

- Generally, the air mass located on one side of a front moves faster than the air mass on the other side. Thus, one air mass actively advances into the region occupied by another and collides with it.
- As one air mass moves into the region occupied by another, minimal mixing occurs along the frontal surface.
- Instead the air masses retain their identity as one is displaced upward over the other. No matter which air mass is advancing, it is always the warmer less dense air that is forced aloft.
- Whereas the cooler, denser air acts as a wedge on which lifting occurs.
- The term **overrunning** is applied to the process of warm air gliding up over a cold air mass.

Types of Fronts

- Warm fronts
- Cold fronts
- Occluded fronts
- Stationary fronts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200
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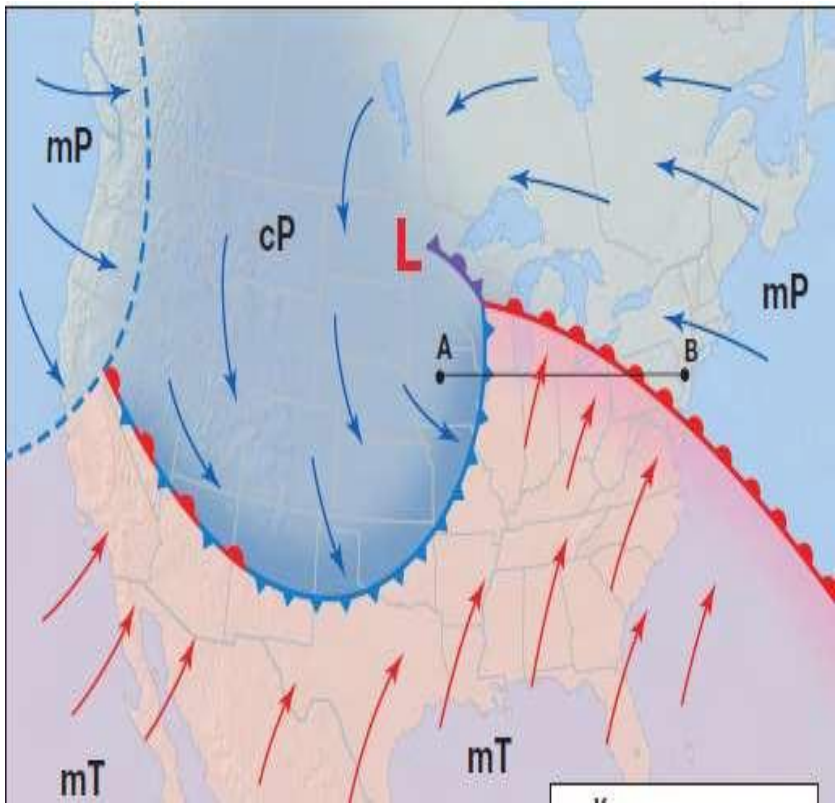
mi
SIMPLIFIED KEY
Cold front
Warm front
Stationary front
Occluded front
Light snow
Light rain
&
Sleet
Wind direction (N)
Wind speed
(10 knots)
22
15
Air temperature
Dew point

Air Masses and Frontal Transitional Zones

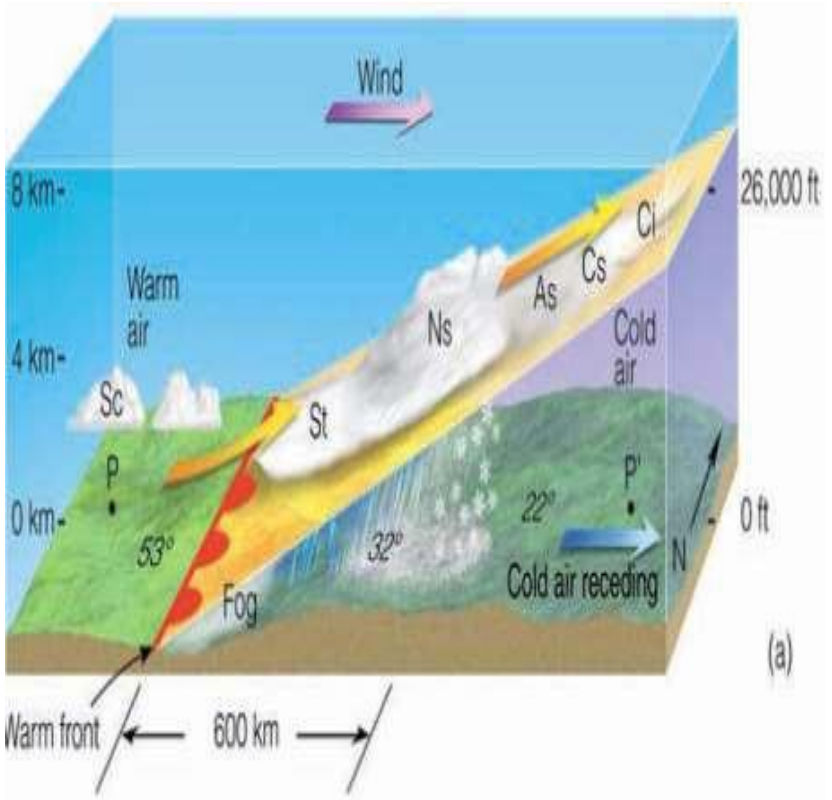
An air mass is a large body of air of relatively similar temperature and humidity characteristics covering thousands of square kilometers. Typically, air masses are classified according to the characteristics of their source region or area of formation. A source region can have one of four temperature attributes: **equatorial, tropical, polar or arctic. Air masses** are also classified as being either continental or maritime in terms of moisture characteristics. Combining these two categories, several possibilities are commonly found associated with North America: maritime polar (mP), continental polar (cP), maritime tropical (mT), continental tropical (cT), and continental arctic (A).

2D view of Fronts



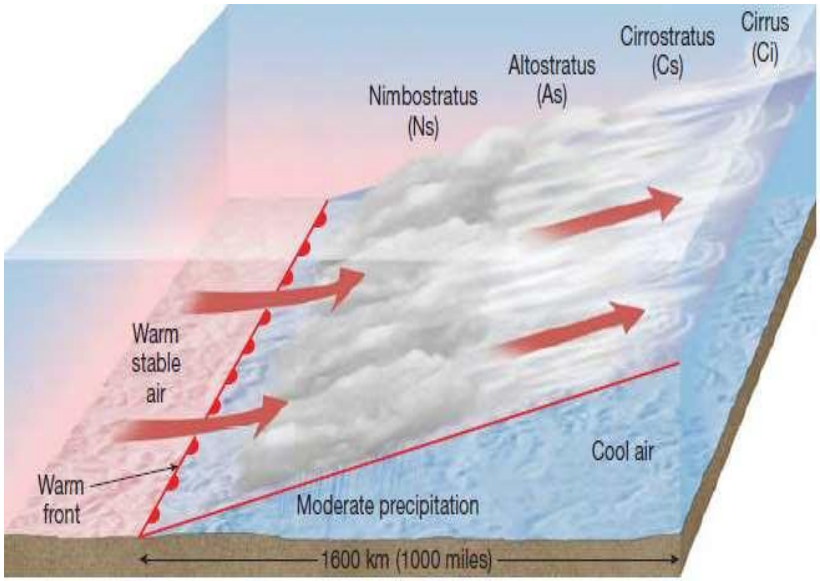
Warm Front

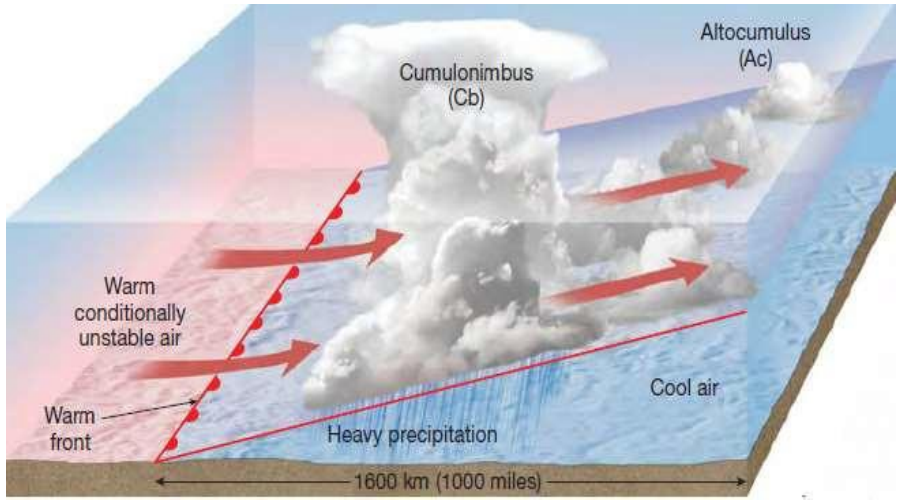
- A warm front is the transition zone in the atmosphere where an advancing warm subtropical, moist air mass replaces a retreating cold, dry polar air mass. On a weather map, a warm front is drawn as a solid red line with half-circles. The position of the half-circles shows the direction of frontal movement. Warm fronts move about 10 kilometers per hour in a northeast direction. This is less than half the speed of a cold front
- Warm fronts are usually as sociated with maritime tropical (mT) air "glides" over cooler air positioned over land.
- The boundaries separating these air masses have very gradual slopes that average about 1:200
- This rising of warm air over cold, called **overrunning**



Clouds Pattern in Warm Front

The formation of clouds and precipitation ahead of the frontal zone is caused by gradual frontal lifting. High altitude cirrus, cirrostratus and middle altitude altostratus clouds are found well in advance of the front. About 600 kilometers ahead of the front, nimbostratus clouds occur. These clouds produce precipitation in the form of snow or rain. Between the nimbostratus clouds and the surface location of the warm front, low altitude stratus clouds are found. Finally, a few hundred kilometers behind the front scattered stratocumulus are common in the lower troposphere. Table 7r-2 describes some of the weather conditions associated with a warm front.



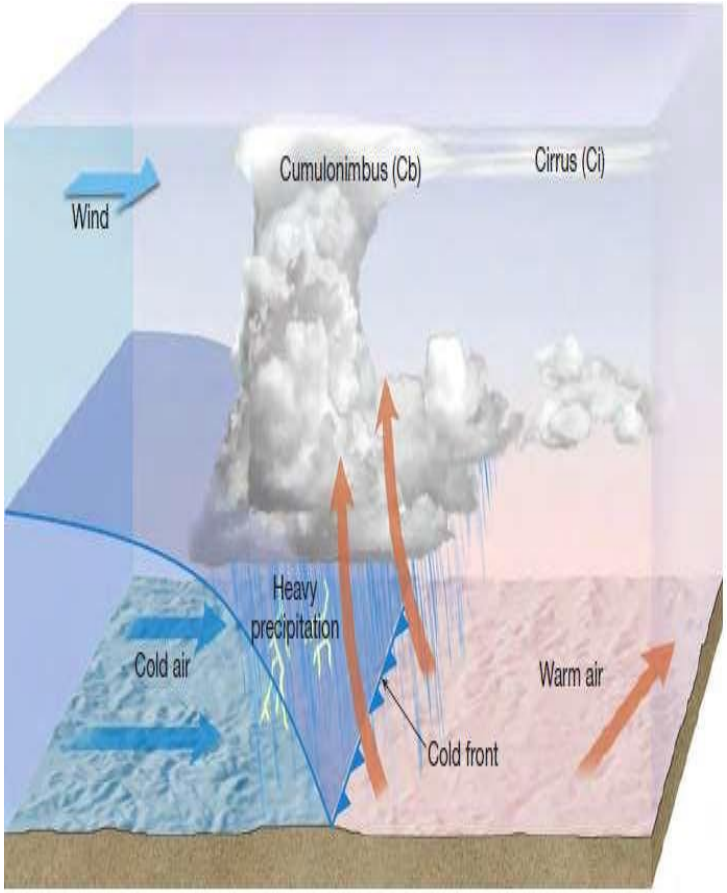


Identification and Frontal Weather

Weather Element	Before Passage	During Passage	After Passage
Temperature	Cool or Cold	Rising	Warmer
Winds	East or southeast	Variable	South or Southwest
Precipitation	Light-to-moderate rain, snow, or freezing rain in winter. Heavy rain possible in summer.	None or light rain	None, occasionally showers in summer
Clouds	Cirrus, cirrostratus, stratus, nimbostratus Cumulonimbus when air is Conditionally unstable.	None, stratus, or fog	Clearing, cumulus, or cumulonimbus in summer
Pressure	Falling	Falling or steady	Falling then rising
Humidity	Moderate to high	Rising	High, particularly in summer

Cold Fronts

A cold front is the transition zone in the **atmosphere** where an advancing cold, dry stable **air mass** displaces a warm, moist unstable subtropical air mass. On a weather map, the cold front is drawn as a solid blue line with triangles. The position of the triangles shows the direction of frontal movement. Cold fronts move between 15 to 50 kilometers per hour in a southeast to east direction. The formation of clouds and precipitation at the frontal zone is caused by frontal lifting. High altitude **cirrus** clouds are found well in advance of the front. Above the surface location of the cold front, high altitude **cirrostratus** and middle ltitude **altocumulus** are common. **Precipitation** is normally found just behind the front where frontal lifting has caused the development of towering **cumulus** and **cumulonimbus** clouds#



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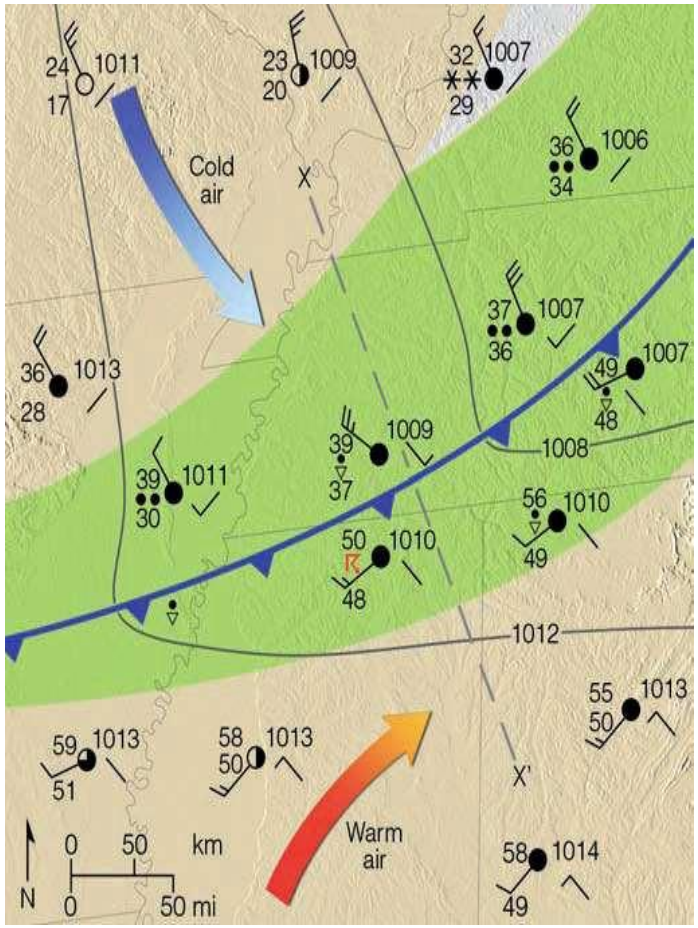
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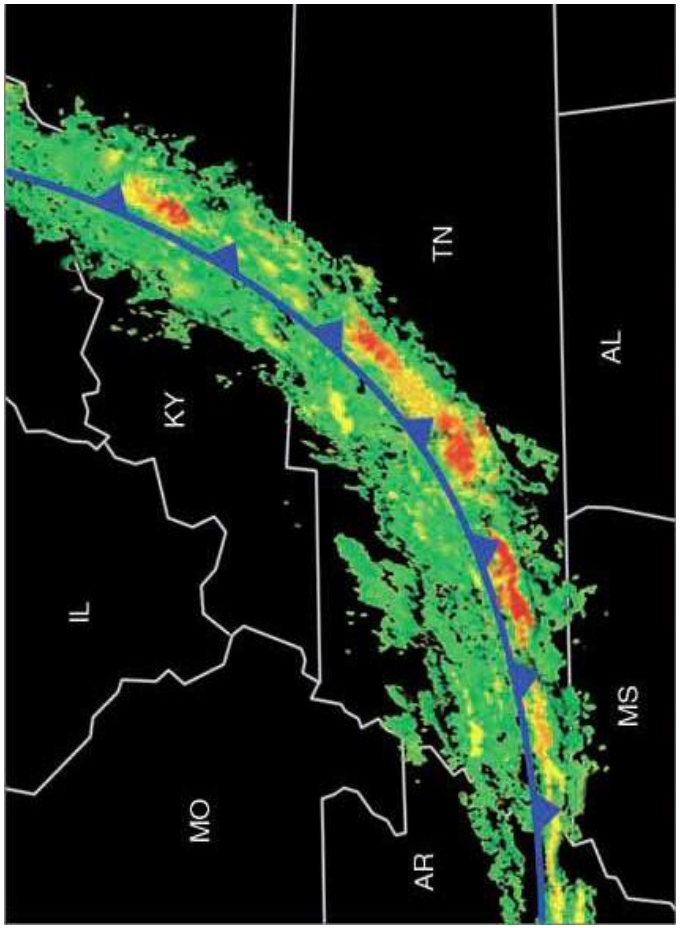
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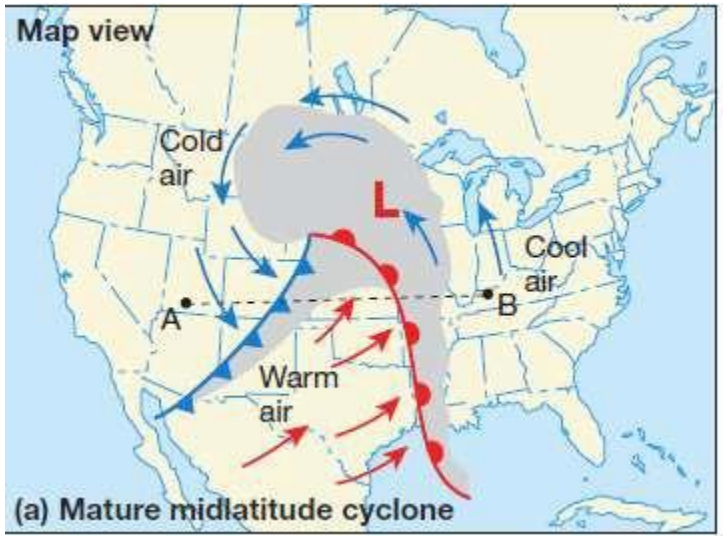
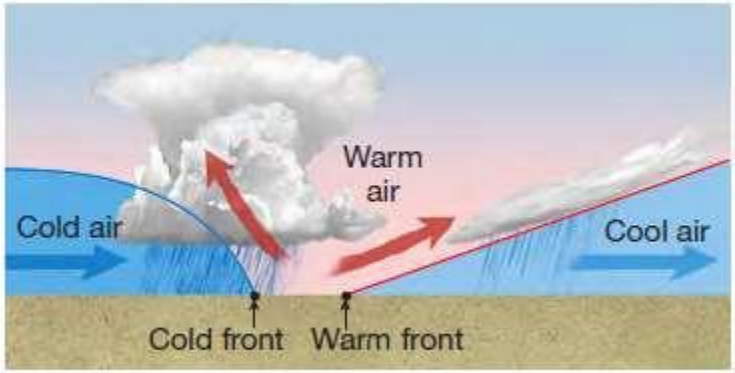
Identification and Frontal Weather

Weather Element	Before Passage	During Passage	After Passage
Temperature	Warm	Sharp drop	Colder
Winds	South or southwest	Variable and gusty	West or northwest
Precipitation	None or showers	Thunderstorms in summer, rain or snow in winter	Clearing
Clouds	None, cumulus, or cumulonimbus	Cumulonimbus	None or cumulus in summer
Pressure	Falling then rising	Rising	Rising
Humidity	High, particularly in summer	Dropping	Low, particularly in winter

Occluded Fronts

- Occluded fronts are produced when a fast moving cold front catches and overtakes a slower moving warm front. Two types of occluded fronts are generally recognized. A cold type occluded front occurs when the air behind the front is colder than the air ahead of the front. When the air behind the front is warmer than the air ahead of the front a warm type occluded front is produced. Warm type occlusions are common on the west coast of continents and generally form when maritime polar air collides with continental polar or arctic air. The cross-section diagram in Figure illustrates a cold type occlusion. Note that in the occlusion process the invading mild moist air that was found behind the warm front has been lifted into the upper troposphere.





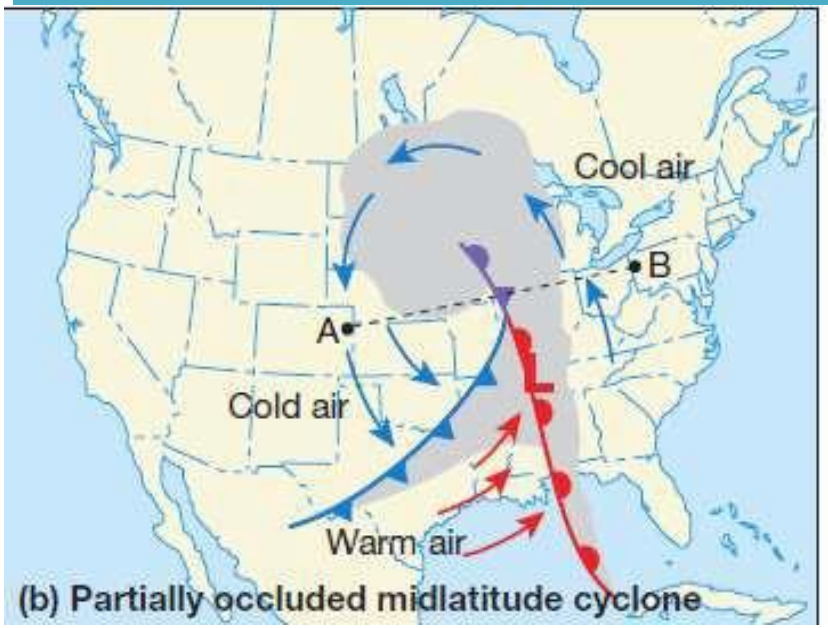
الجبهة الملتحمة

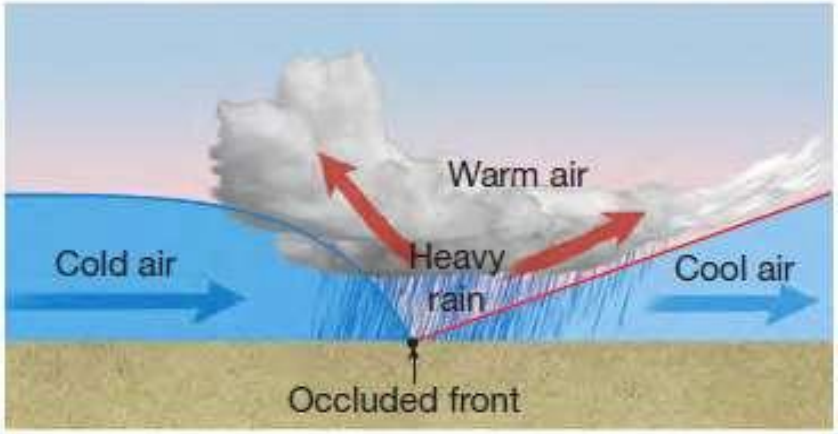
: (أو الجبهة المسدودة) في علم الأرصاد الجوية هي ظاهرة مناخية تحصل عند قدوم جبهة هوائية باردة لتحل محل جبهة دافئة، مما يؤدي إلى حصر الهواء الدافئ (مكان مقفل) لينتقل من المركز إلى الأطراف القريبة من سطح الأرض. يسمى مكان الالتقاء اصطلاحاً باسم النقطة الثلاثية.[2]

تنتشر الجبهات الملتحمة في أماكن المنخفضات الجوية، وتصنف إلى نوعين:

جبهة ملتحمة باردة تكون فيها الكتلة الهوائية أبرد من الهواء الموجود في الجبهة الدافئة التي تحل محلها.

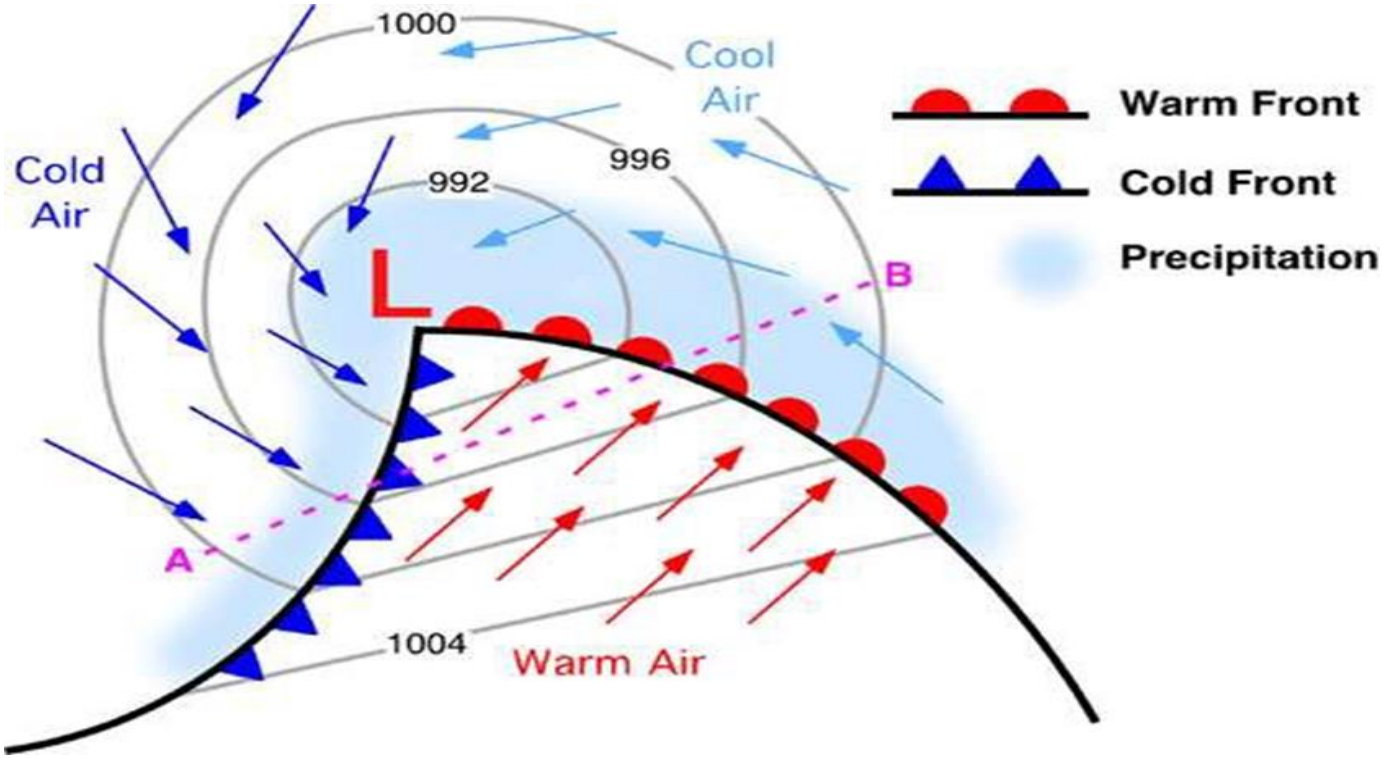
جبهة ملتحمة دافئة تكون فيها الكتلة الهوائية ليست بردجة برودة الهواء الموجود في الجبهة الدافئة التي تحل محلها.





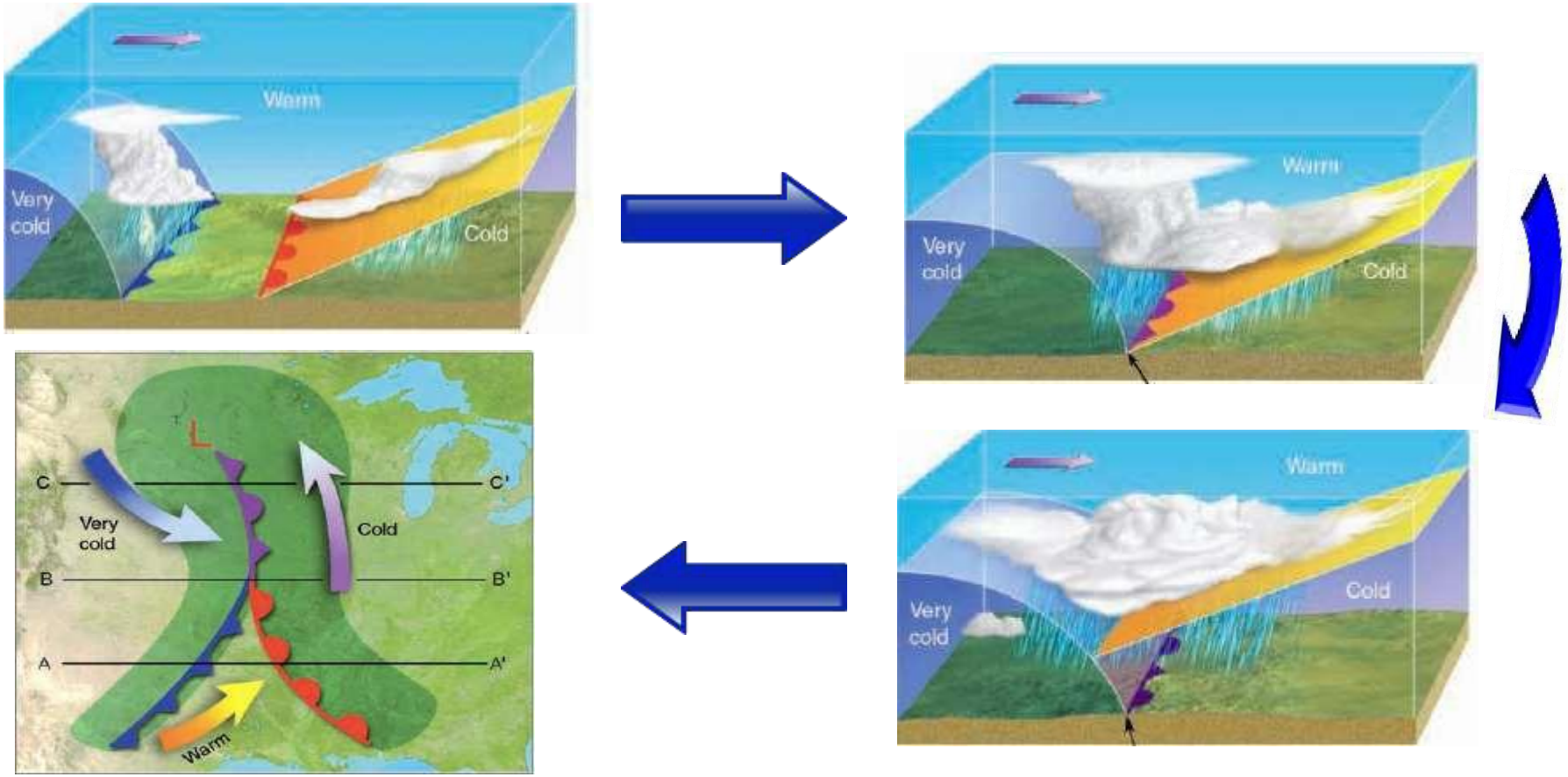
Occluded Front Helps to Generate a Mid-Latitude Cyclone

when a cold front overtakes a warm front A developing cyclone typically has a preceding warm front (the leading edge of a warm moist air mass) and a faster moving cold front (the leading edge of a colder drier air mass wrapping around the storm). North of the warm front is a mass of cooler air that was in place before the storm even entered the region.



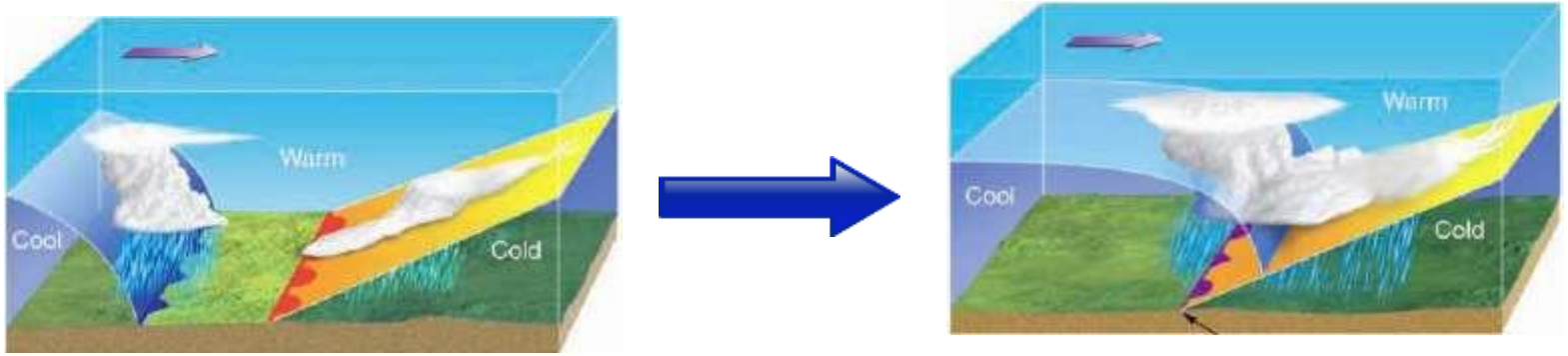
Types of Occlusion-
Cold-Type Occluded Fronts

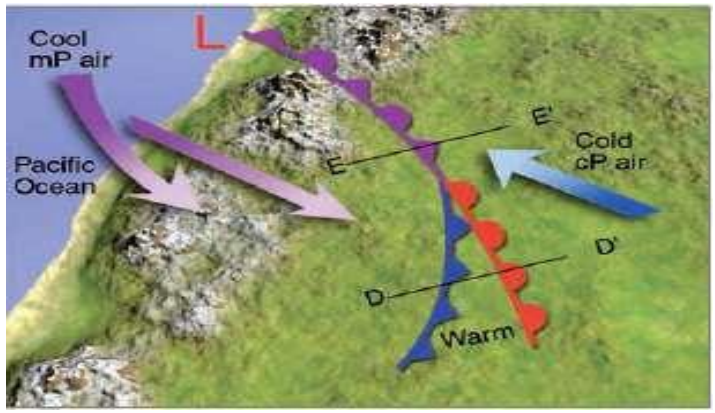
During the formation of an occluded front, the Bergen meteorologists believed that if the polar air behind the cold front was colder (and thus denser) than the polar air ahead of the warm front, then this less dense air and the associated warm front would ride up off the ground over the cold front as the occluded front formed. This type of structure is called a cold-type occlusion.



Warm-Type Occluded Fronts

A warm air occlusion or occluded front is less common than a cold occlusion. A warm occlusion occurs as cool air moves rapidly into an area with an existing warm front. The difference from a cold occlusion is that the approaching cool air is not as cold as the retreating *cold* air in the existing front. In other words, the fast-moving, incoming air is cold, but not as cold as the air mass ahead of it. Precipitation can usually be expected when an occluded front passes through an area.



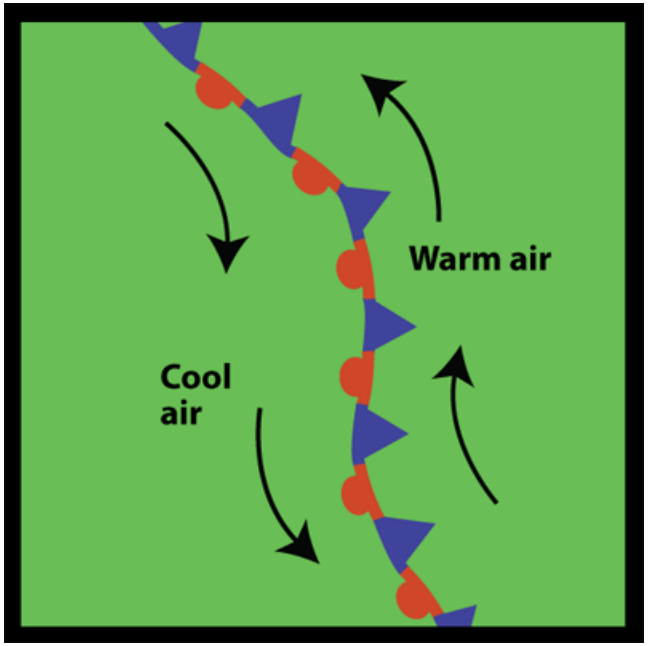


	Before Passing	While Passing	After Passing
Winds	southeast-south	variable	west to northwest
Temperature **Cold Type** **Warm Type**	 cold-cool cold	 dropping rising	 colder milder
Pressure	usually falling	low point	usually rising
Clouds	in order: Ci, Cs, As, Ns	Ns, sometimes Tcu and Cb	Ns, As or scattered Cu
Precipitation	light, moderate or heavy precipitation	light, moderate or heavy continuous precipitation or showers	light-to-moderate precipitation followed by general clearing
Visibility	poor in precipitation	poor in precipitation	improving
Dew Point	steady	usually slight drop, especially if cold-occluded	slight drop, although may rise a bit if warm-occluded

Stationary Fronts

A stationary front forms when a cold front or warm front stops moving. This happens when two masses of air are pushing against each other but neither is powerful enough to move the other. Winds blowing parallel to the front instead of perpendicular can help it stay in place.

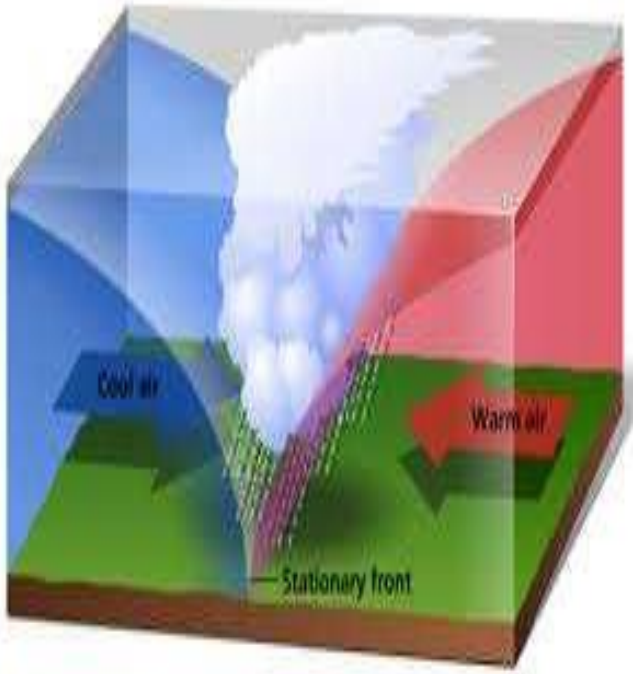
A stationary front may stay put for days. If the wind direction changes the front will start moving again, becoming either a cold or warm front. Or the front may break apart.



Weather Typically Associated with a stationary Front

Because a stationary front marks the boundary between two air masses, there are often differences in air temperature and wind on opposite sides of it. The weather is often cloudy along a stationary front and rain or snow often falls, especially if the front is in an area of low atmospheric pressure.

On a weather map, a stationary front is shown as alternating red semicircles and blue triangles like in the map at the left. The blue triangles point in one direction and the red semicircles point in the opposite direction

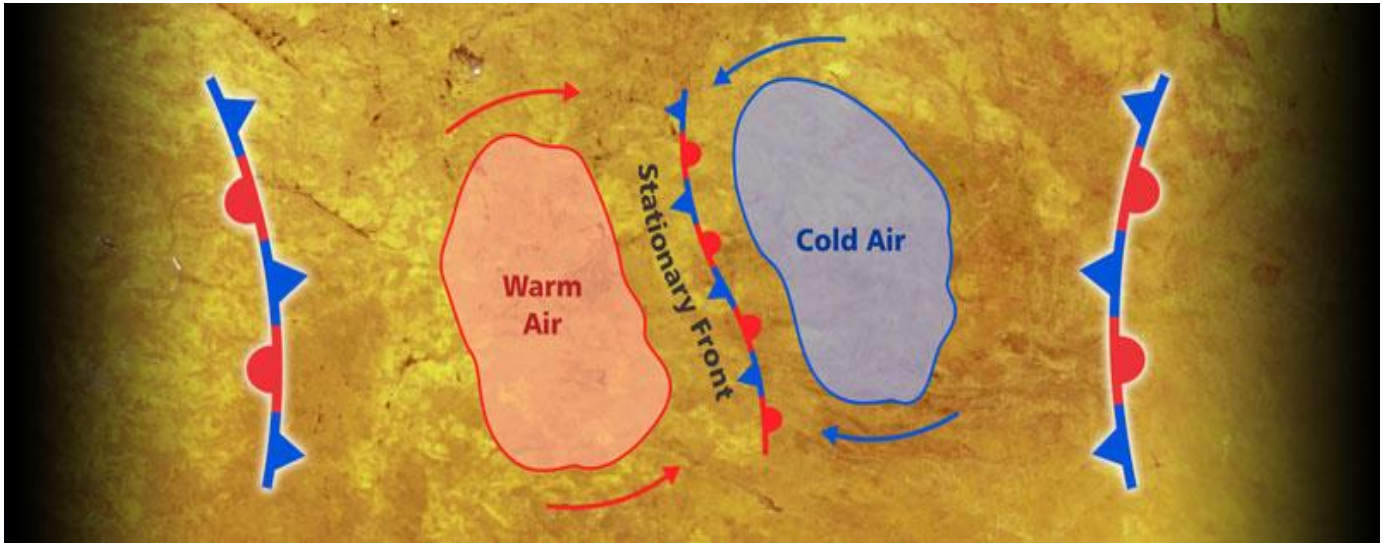


What Weather Does A Stationary Front Bring?

The weather that accompanies a stationary front is not nearly as dormant as the movement of the front itself. It is not uncommon to find winds blowing parallel to the direction of a stationary front.

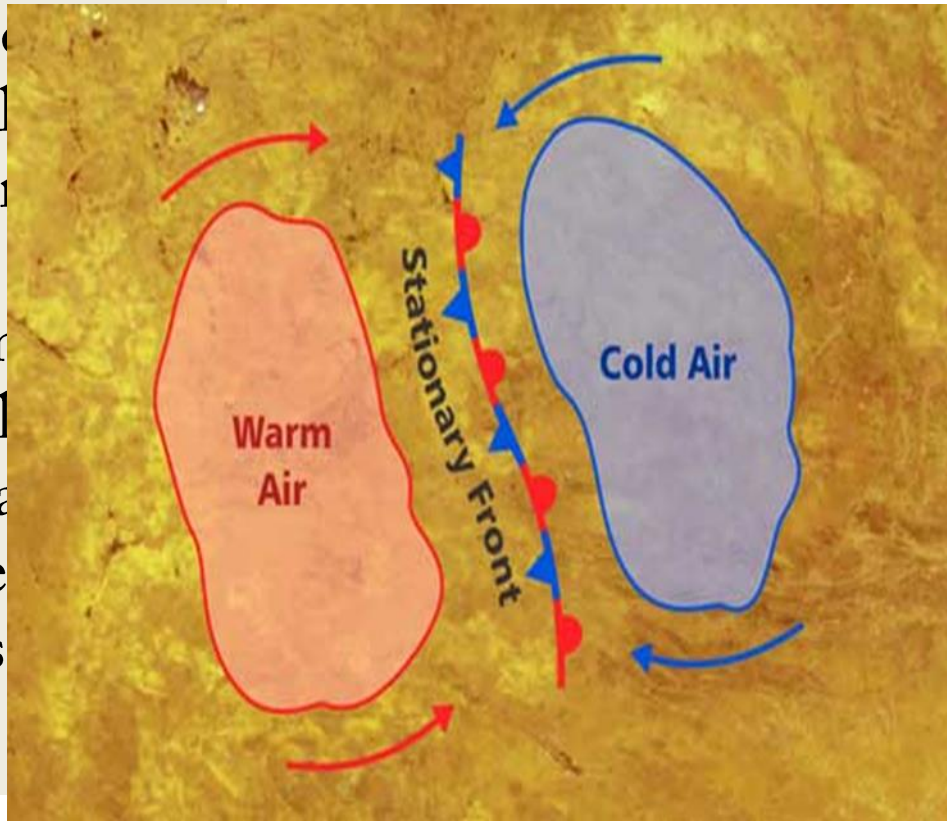
Another characteristic of a stationary front is the distinct difference in temperature experienced on either side of this "fixed barrier." The mass of air behind the approaching warm front has a much higher temperature than the mass of air behind the approaching cold front.

A stationary front is also often accompanied by overcast and dreary weather with persistent light precipitation that can last for days. This condition usually depends on the amount of moisture present in the air.



On occasion, a stationary front can lead to extreme events. When a high percentage of moisture is present in the atm heavy & persistent rain can l flooding in the region along the fro

Heavy winds called derechos so develop due to strong downdrafts al border of a stationary front. They ca speeds of 160 km/h (100 miles pe which can cause damage to infras and endanger human life.



Thanks ☺

May the force be with you