Weather fronts

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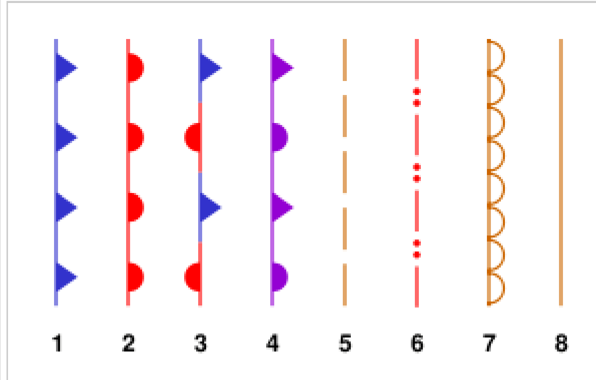
Weather fronts lie at the interface of two air masses of different density and are the principal cause of significant weather, and are depicted within surface weather analyses using various colored lines and symbols. The air masses fronts separate generally differ in temperature and may also differ in humidity.



A guide to the symbols for weather fronts that may be found on a weather map:
1. cold front
2. warm front
3. stationary front
4. occluded front
5. surface trough
6. squall/shear line
7. dry line
8. tropical wave

Cold fronts feature narrow bands of thunderstorms and severe weather. Squall lines and dry lines can can precede cold fronts. Stratiform precipiptation and fog is seen in advance of warm fronts. Clearing is rapid after the passage of moving frontal boundaries. Cold and occluded fronts move from west to east, while warm fronts move poleward. Cold fronts and cold occlusions move quicker than warm fronts and warm occlusions due to the greater density of air in their wake. Mountains and warm bodies of water can slow down the movement of fronts. When a front becomes stationary, it can degenerate into a line which separates regions of differing wind speed known as a shearline. In the tropics, tropical waves move from east to west across the Atlantic and eastern Pacific basins. They generate most of the tropical cyclones seen in the Atlatic basin, and a significant percentage of tropical cyclones spawned in the eastern Pacific ocean.

Contents

Surface weather analysis

A surface weather analysis is a special type of weather map which provides a view of weather elements over a geographical area at a specified time based on information from ground based weather stations.[1] Weather maps are created by plotting or tracing the values of relevant quantities such as sea level pressure, temperature, cloud cover onto a geographical map to help find synoptic scale features such as weather fronts. Surface weather analyses have special symbols which show frontal systems, cloud cover, precipitation, or other important information. For example, an *H* may represent high pressure, implying good and fair weather. An *L* on the other hand may represent low pressure, which frequently accompanies precipitation. Various symbols are used not just for frontal zones and other surface boundaries on weather maps, but also to depict the present weather at various locations on the weather map. Areas of precipitation help determine the frontal type and location.

Cold front

A cold front's location is at the leading edge of the temperature drop off, which in an isotherm analysis would show up as the leading edge of the isotherm gradient, and it normally lies within a sharp surface trough. Cold fronts can move up to twice as fast and produce sharper changes in weather than warm fronts, since cold air is denser than warm air it rapidly replaces the warm air preceding the boundary. Cold fronts are typically accompanied by a narrow band of showers and thunderstorms. On weather maps, the surface position of the cold front is marked with the symbol of a blue line of triangles/spikes (pips) pointing in the direction of travel, and it is placed at the leading edge of the cooler air mass.[2]

Warm front

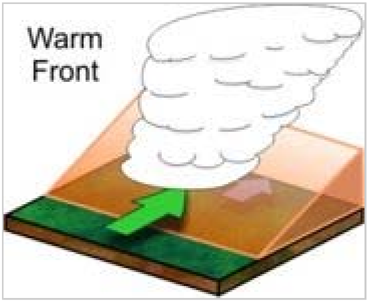
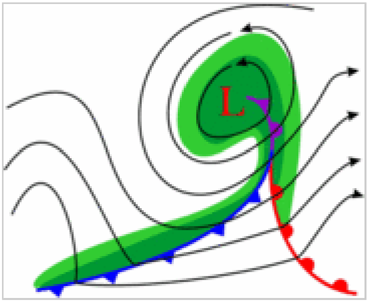


Illustration clouds overriding a warm front

Warm fronts are at the leading edge of the temperature drop off, which is located on the equator-ward edge of the gradient in isotherms, and lie within broader troughs of low pressure than cold fronts. Warm fronts move more slowly than the cold front which usually follows due to the fact that cold air is more dense, and harder to remove from the earth's surface. This also forces temperature differences across warm fronts to be broader in scale. Clouds ahead of the warm front are mostly stratiform and rainfall gradually increases as the front approaches. Fog can also occur preceding a warm frontal passage. Clearing and warming is usually rapid after frontal passage. If the warm air mass is unstable, thunderstorms may be embedded among the stratiform clouds ahead of the front, and after frontal passage, thundershowers may continue. On weather maps, the surface location of a warm front is marked with a red line of half circles pointing in the direction of travel.[2]

Occluded front



Occluded cyclone frontal depiction

An occluded front is formed during the process of cyclogenesis when a cold front overtakes a warm front.[3] The cold and warm fronts curve naturally poleward into the point of occlusion, which is also known as the triple point in meteorology.[4] It lies within a sharp trough, but the air mass behind the boundary can be either warm or cold. In a cold occlusion, the air mass overtaking the warm front is cooler than the cool air ahead of the warm front, and plows under both air masses. In a warm occlusion, the air mass overtaking the warm front is not as cool as the cold air ahead of the warm front, and rides over the colder air mass while lifting the warm air. A wide variety of weather can be found along an occluded front, with thunderstorms possible, but usually their passage is associated with a drying of the air mass. Occluded fronts are indicated on a weather map by a purple line with alternating half-circles and triangles pointing in direction of travel.[2] Occluded fronts usually form around mature low pressure areas.

Stationary fronts and shearlines

A stationary front is a non-moving boundary between two different air masses, neither of which is strong enough to replace the other. They tend to remain essentially in the same area for extended periods of time, usually moving in waves.[5] There is normally a broad temperature gradient behind the boundary with more widely spaced isotherm packing. A wide variety of weather can be found along a stationary front, but usually clouds and prolonged precipitation are found there. Stationary fronts will either dissipate after several days or devolve into shear lines, but can change into a cold or warm front if conditions aloft change. Stationary fronts are marked on weather maps with alternating red half-circles and blue spikes pointing in opposite directions, indicating no significant movement.

When stationary fronts become smaller in scale, degenerating to a narrow zone where wind direction changes significantly over a relatively short distance, they become known as shear lines.[6] If the shear line becomes active with thunderstorms, it may support formation of a tropical storm or a regeneration of the feature back into a stationary front. A shear line is depicted as a line of red dots and dashes.[2]

Movement of fronts

Fronts are generally guided by winds aloft, but they normally move at lesser speeds. Cold fronts and occluded fronts travel from a west to east direction, while warm fronts move more poleward with time. Movement is largely due to the pressure gradient force (due to horizontal differences in atmospheric pressure) and the Coriolis effect, caused by the earth spinning about its axis. Frontal zones can be slowed down by geographic features like mountains and large bodies of warm water.[2]

Types of precipitation produced by fronts

See also: Convective precipitation and Orographic precipitation

Fronts are the principal cause of significant weather. *Convective precipitation* (showers, thundershowers and related unstable weather) is caused by air being lifted and condensing into clouds by the movement of the cold front or cold occlusion under a mass of warmer, moist air. If the temperature differences of the two air masses involved are large and the turbulence is extreme due to wind shear and the presence of a jet max, "roll clouds" and tornadoes may occur. [7] In the warm season, lee troughs, sea/lake/river/land breezes, outflow boundaries, and trowals/occlusions can lead to convection if enough moisture is available. *Orographic precipitation* refers to precipitation generated through the lifting action of air moving over terrain such as mountains and hills, which is most common behind cold fronts that move into mountainous areas. It may also sometimes occur in advance of warm fronts moving northward to the east of mountainous terrain. Precipitation along warm fronts, however, is relatively steady, as in rain or drizzle. Fog, sometimes extensive and dense, is often present in pre-warm-frontal areas.[8] It should be noted that not all fronts produce precipitation or even clouds. Moisture must be present in the air mass which is being lifted.[9]

Dry line

A similar phenomenon to a frontal zone is the dry line, which is the boundary between air masses with significant moisture differences. When westerly winds aloft increase on the north side of surface highs, areas of lowered pressure will form downwind of north-south oriented mountain chains, leading to the formation of a lee trough. Near the surface during daylight hours, warm moist air is more dense than dry air of greater temperature, and thus the warm moist air wedges under the drier air like a cold front. At higher altitudes, the warm moist air is less dense than the dry air and the boundary slope reverses. In the vicinity of the reversal aloft, severe weather is possible, especially when a triple point is formed with a cold front.[10] A weaker form of the dry line seen more commonly is the lee trough, which displays weaker differences in moisture. If moisture pools along with boundary during the warm season, it can be the focus of diurnal thunderstorms.[11]

The dry line may occur anywhere on the globe in regions intermediate between desert areas and warm seas. The southern plains west of the Mississippi in the U.S. are a particularly favored location. The dry line normally sloshes eastward during the day, and westward at night. A dry line is depicted on NWS surface analyses as a brown line with scallops facing into the moist sector. Dry lines are one of the few surface fronts where the pips indicated do not necessarily reflect the direction of motion.[12]

Squall lines

A shelf cloud such as this one can be a sign that a squall is imminent

Organized areas of thunderstorm activity not only reinforce pre-existing frontal zones, but they can outrun cold fronts in a pattern where the upper level jet splits into two streams, with the resultant Mesoscale Convective System (MCS) forming at the point of the upper level split in the wind pattern running southeast into the warm sector parallel to low-level thickness lines. When the convection is strong and linear or curved, the MCS is called a squall line, with the feature placed at the leading edge of the significant wind shift and pressure rise.[13] Even weaker and less organized areas of thunderstorms will lead to locally cooler air and higher pressures, and outflow boundaries exist ahead of this type of activity, which can act as foci for additional thunderstorm activity later in the day.[14] These features will commonly be depicted in the warm season across the United States on surface analyses, and they lie within surface troughs. If outflow boundaries or squall lines form over arid regions, a haboob may result.[15] Squall lines are depicted on NWS surface analyses as an alternating pattern of two red dots and a dash labelled SQLN or SQUALL LINE, while outflow boundaries are depicted as troughs with a label of OUTFLOW BNDRY.

Tropical waves

Tropical wave formation.

Atlantic tropical waves develop from disturbances which drift off the continent of Africa onto the Atlantic ocean. These are generated or enhanced by the African Easterly Jet. The clockwise circulation of the large transoceanic high-pressure cell or anticyclone centered near the Azores islands moves easterly waves away from the coastal areas of Africa towards North America. Approximately 60% of Atlantic tropical cyclones originate from tropical waves, while approximately 85% of intense Atlantic hurricanes (Category 3 and greater) develop from tropical waves."[16][17] Tropical cyclones can sometimes degenerate back into a tropical wave. This normally occurs if upper-level wind shear is too strong. The storm can redevelop if the upper level shear abates. If a tropical wave is moving quickly, it can have strong winds of over tropical storm force, but is not considered a tropical storm unless it has a closed circulation. An example of this was Hurricane Claudette in 2003, where the original wave had winds of 45 mph before developing a circulation. Tropical waves are depicted with a solid orange line on the National Weather Service Unified Surface Analysis.[2]

See Also

- Cyclogenesis
- Extratropical cyclone
- Surface weather analysis

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