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WEATHER PREDICTIONS AND CLOUD FORMATIONS

Unit Overview

In this unit you will learn of the relationship between cloud types and weather forecasting. Clouds give us clues about what is going on in the atmosphere and how the weather might change the hours or the days to come. Each type of cloud forms in a different way, and each generates its own kind of weather.

Unit Directions

Read the text carefully and intently, study the visuals, and answer the questions that follow at the conclusion of this unit.

Introduction

Clouds are water. As you know from previous units, water is found in three forms: liquid, solid and gas. Water in the gaseous form is called water vapor. Warm air can hold more moisture than cold air. As warm, moist air rises in the atmosphere, its temperature begins to drop. Because cold air cannot hold as much water vapor as warm air, the rising air soon becomes saturated. At this point, the water vapor in the air begins to condense, or change into a liquid. The temperature at which water vapor condenses is called the **dew point**. Clouds form when water vapor turns back into liquid water droplets. It happens in one of two ways: when the air cools enough, or when enough water vapor is added to the air. You've seen the first process happen on a summer day as drops of water gather on the outside of a glass of ice tea. That's because the cold glass cools the air near it, causing the water vapor in the air to condense into liquid. Unlike the drops on the side of your glass though, the droplets of water in a cloud are so small that it takes about one million of them to form a single raindrop. While most clouds form this way, cooling comes not from ice in a glass but as the air rises and cools high in the sky. Each tiny cloud droplet is light enough to float in the air, just as a little cloud of vapor floats out from your breath on a cold day.

Air has to be just a little bit dirty for clouds to form because water vapor needs a surface on which to condense. Fortunately, even the cleanest air has some microscopic particles of dust, smoke, or salt for water droplets to cling to, so the air is rarely too clean for clouds to form.

CLASSIFICATIONS OF CLOUDS

A cloud is a visible collection of very fine water droplets or ice crystals suspended in the atmosphere at altitudes from just above the ground to several miles above sea level. As you can see for yourself just from looking at the sky, clouds come in all sorts of shapes and sizes. Meteorologists name clouds by **how high** in the sky they form and by their **appearance**. Most clouds have two parts to their name. Usually the first part of the name has to do with the **height** and the second part refers to the **appearance**.

Cloud Heights

High clouds

If clouds form at the highest levels, they get the prefix "cirr-" as the first part of their name. In Latin, cirrus means "curl of hair." Sometimes cirrus clouds are also called mares' tails.

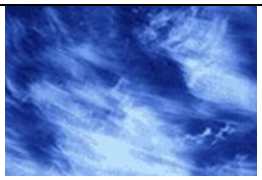
Cirrus

High cirrus cloud forms include detached clouds of delicate and fibrous appearance, generally white in color, often resembling tufts or featherlike plumes, and composed entirely of ice crystals; cirrocumulus (mackerel sky) clouds are composed of small white flakes or very small globular masses, arranged in groups, lines, or ripples; and cirrostratus clouds are a thin whitish veil, sometimes giving the entire sky a milky appearance, which does not blur the outline of the sun or moon but frequently produces a halo.

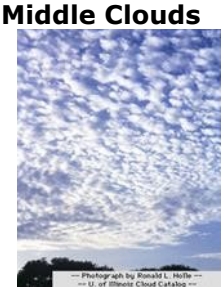
High-level clouds form above 20,000 feet and since the temperatures are so cold at such high elevations, these clouds are primarily composed of ice crystals. **Cirrus** clouds, which are a sign of warm moist air rising up over cold air, are sometimes an early signal that thickening clouds could bring light rain or snow within one or two days.

Although high-level clouds are typically thin and white in appearance like wisps of white hair, they can appear in a magnificent array of colors when the sun is low on the horizon. (Refer below to a photo.)

High Level Clouds

High Clouds (18,000 feet and above)		
		
CIRRUS clouds are white, ice crystal clouds, wispy in appearance. They may take on the appearance of a mare's tail because as ice crystals fall from the cloud they often encounter changing winds and so "tail" off.	CIRROSTRATUS clouds are a thin veil of ice crystals usually covering most or all of the sky. A "halo" may appear around the sun or moon due to refraction (or bending) or light rays in the ice crystals; cirrostratus clouds are often a sign of approaching storms.	CIRROCUMULUS clouds are milky-white with a dappled or wave-like appearance. During the day, refraction of the sun's rays may cause one or more "mock-suns" to appear on either side of the sun.

Middle Clouds



Middle clouds get the prefix "alto." Intermediate clouds include altocumulus, patchy layer of flattened globular masses arranged in groups, lines, or waves, with individual clouds sometimes so close together that their edges join; and altostratus, resembling thick cirrostratus without halo phenomena, like a gray veil, through which the sun or the moon shows vaguely or is sometimes completely hidden.

The bases of mid-level clouds typically appear between 6,500 to 20,000 feet. Because of their lower altitudes, they are composed primarily of water droplets; however, they can also be composed of ice crystals when temperatures are cold enough. Refer below to a photo of mid-level clouds.

Middle Clouds (7000-18000 Feet)		
		
ALTOSTRATUS clouds are gray or blue-gray clouds composed of water droplets or a mix of water droplets and ice crystals. Sun may be dimly visible as through ground glass. Altostratus clouds are often a sign of approaching rain or snow.	**Altostratus** clouds form a bluish or grayish veil that totally or partially covers the sky. The sun can barely be seen through altostratus and its edges are not distinct. Altostratus clouds are water or ice clouds, and they do not produce halos. Altostratus is classified as a middle cloud. Featureless altostratus clouds are thin enough (translucent) to show the sun in the late afternoon, on 6 December 1989 at Boulder, Colorado, USA. Note that the sun has blurry edges. (Photo © 1989 Ronald L. Holle.)	**ALTOCUMULUS** clouds are patchy with a wave-like or dappled appearance. They are distinguished from Cirrocumulus by the color which is gray or blue gray (Cirrocumulus is milky-white); sometimes they are referred to as a "Mackerel sky." Altocumulus clouds take many forms. They can look like waves on the sea, tiny cumulus, balls of cotton, or even little castle towers. The individual "cloudlets" are usually between one and two fingers wide at arm's length. They

		are thick enough to have gray bases. Altocumulus clouds are almost always made up of water droplets, but sometimes contain ice crystals as well. The tiny water droplets in altocumulus can produce rainbow-like colors. Most commonly, this is in the form of rainbow-colored circles around the sun or moon. This is called an "aureole." An aureole is commonly around the width of a fist, held at arm's length. Altocumulus is classified as a middle cloud.

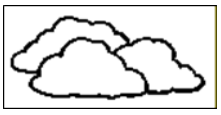
Low Clouds

Low clouds don't get a prefix.They are mostly composed of water droplets since their bases generally lie below 6,500 feet. Low clouds include stratocumulus, a cloud layer or patches composed of fairly large globular masses or flakes, soft and gray with darker parts, arranged in groups, lines, or rolls, often with the rolls so close together that their edges join; stratus, a uniform layer resembling fog but not resting on the ground; and nimbostratus, a nearly uniform, dark grey layer, amorphous in character and usually producing continuous rain or snow. However, when temperatures are cold enough, these clouds may also contain ice particles and snow. Refer below to a photo of low-level clouds.

Cloud Appearance

There are two **cloud appearance** types: **cumulus** and **stratus**, which are also the basic names of the low clouds. Sometimes they appear higher in the atmosphere and get a combination name with a prefix. For example, middle cumulus clouds are called "altocumulus" and high stratus clouds are "cirrostratus." If a cloud produces rain or snow it gets either "**nimbo**" at the beginning or "nimbus" at the end. In Latin, **nimbus** means rain cloud.

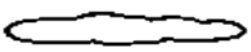
Cumulus Clouds



Cumulus clouds are low individual billowy globs that are low, have flat bases and look a little like cauliflower. In Latin, cumulus means "heap." Cumulus clouds look like a heap of cotton balls or whipped cream. They are at least as tall as they are wide and form on sunny days from pockets of rising air. Their constantly changing outlines are fun to watch because they can take the shapes of almost anything, including animals and faces. Cumulus clouds often have a horizontal base and a dome-shaped upper surface that frequently resembles a head of cauliflower and shows strong contrasts of light and shadow when the sun illuminates it from the side. Cumulus clouds usually signal fair weather.

However, when cumulus clouds build into the middle or high part of the atmosphere and get larger and darker on the bottom, they get the name cumulo**nimbus**, a thunderstorm cloud with heavy masses of great vertical development whose summits rise in the form of mountains or towers. The upper parts have a fibrous texture, often spreading out in the shape of an anvil, and sometimes reaching the stratosphere. **Cumulonimbus** clouds are tall, deep, and dark and can bring showers of rain, snow, or thunderstorms, lightning, heavy rain and even severe weather such as hail, damaging winds or tornadoes. They are a sign of rapidly rising and sinking air currents.

Stratus Clouds



Stratus clouds are layered and cover most of the sky. In Latin, stratus means "covering" or "blanket." Stratus clouds look like a flat blanket in the sky. They are much wider than they are tall.

			
Stratus clouds are usually gray seen from below, fairly uniform horizontally, and lie close to the surface of the Earth. They usually look like a solid layer but are sometimes found in patches. Stratus clouds can produce light precipitation. They are usually water clouds. When the sun is visible through stratus clouds, its edges are distinct. Stratus is classified as a low cloud.	If you see stratus clouds in broken or puffy layers, they are **stratocumulus** clouds. **Stratocumulus** clouds are gray or whitish. Both the tops and bottoms of these bases are rounded. They can look like waves on the ocean, joined flat cumulus, or a continuous but irregular layer. They can form from spreading out cumulus clouds, or from a stratus layer. Stratocumulus is most commonly made up of water droplets and classified as a low cloud.	If you see stratus clouds in thin high layers that turn the sky solid white, they're **cirro**stratus clouds. **Cirrostratus clouds** are a thin, transparent, whitish layer made up of ice crystals. They may partially or totally cover the sky. Tiny prisms of ice in a cirrostratus layer can bend the sun's light. As a result, often you can see a halo or veil of rainbow colors around the sun. These patches of rainbow-colored light are sometimes called "sundogs" and occur on the halo on both sides of the sun. Cirrostratus is classified as a high cloud.	When stratus clouds are very thick, they become dark **nimbo**stratus clouds that can produce rain, drizzle or snow **Nimbostratus** clouds are usually gray, and you cannot see the sun through them. They are associated with continuous precipitation that often makes the bottom of the cloud hard to see. Sometimes it is difficult to tell a nimbostratus cloud from a cumulonimbus cloud. However, if there is lightning and thunder, the cloud is probably cumulonimbus. Also, showery (intermittent) precipitation is associated with cumulonimbus. Nimbostratus clouds from photographs can often be mistaken for stratocumulus or stratus clouds, and vice versa, because it is often difficult to judge whether or not rain is present from a photograph. Nimbostratus is classified as a low cloud, but it can also be classified as a middle cloud. When **stratus clouds** form close to the ground, the result is fog.

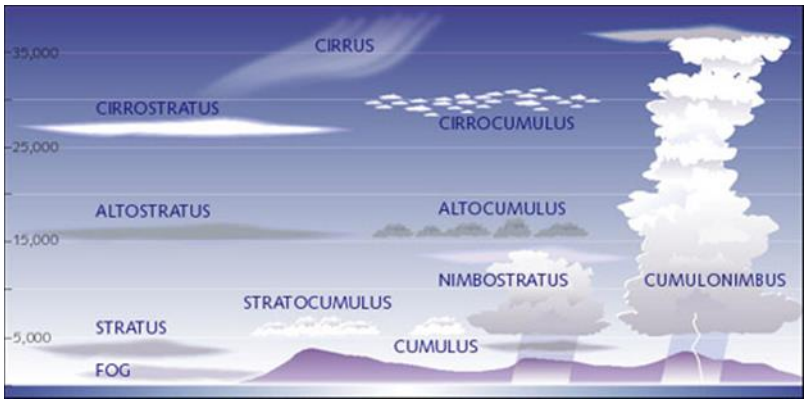
LOW CLOUDS (below 7000 feet)


STRATUS clouds are low, gray, flat water droplet clouds (called fog if they touch the ground) with no clear structure. Drizzle may occur from these clouds.

STRATOCUMULUS clouds are low layered clouds with some observed structure and varying color. Often stratocumulus clouds are the result of both mixing and low-level instability. They are a sign of blustery and relatively cool conditions with possible showers or rain or snow.

CUMULUS clouds are small heaped clouds with flat bottoms and rounded tops and most commonly seen in an otherwise blue sky. They are usually a sign of fair weather and thus often referred to as Fair Weather Cumulus.

Summary of Cloud Classifications



FRONTS

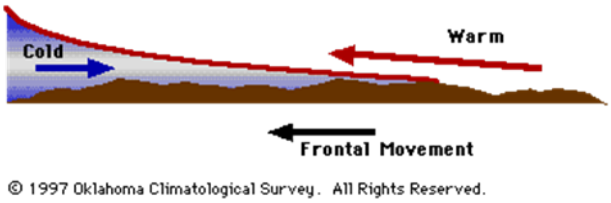
Fronts are boundaries between two air masses of different temperatures. Fronts are actually zones of transition, but sometimes the transition zone, called a frontal zone, can be quite sharp. The type of front depends on both the direction in which the air mass is moving and the characteristics of the air mass. The four types of fronts discussed in this unit include: cold front, warm front, stationary front, and occluded front.

The frontal zone represents the leading edge of a wedge of cold/cool air. If the wedge is moving into an area of warmer air, the front is called a cold front. If the wedge is retreating and warmer air is moving into an area previously occupied by cool air, the front is termed a warm front.

Warm Fronts

A warm front is a surface along which advancing warm air displaces cold air. A warm front is slower than a cold front. 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). Warm fronts are usually preceded by cirrus first (1000 km ahead), then altostratus or altocumulus (500 km ahead), and finally stratus and possibly fog. Behind the warm front, skies are relatively clear but change gradually.

In a warm front, the warm air is ramped up and over the colder, denser air. The warm air is cooled and so clouds and precipitation may develop.



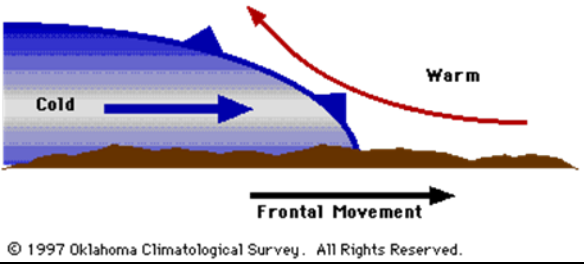
Side View of a Typical Warm Front

Warm fronts are nearly always well defined by tropical stratified clouds. They are generally cirrus, cirrostratus, altostratus, nimbostratus, and stratus with the cirrus appearing as much as 1,000 miles before the actual surface passage. The cloud types that form after passage of the warm front are typical of the warm air mass.

The precipitation area of warm fronts extends about 300 miles in advance of the surface front. Precipitation occurs mainly in the form of continuous or intermittent rain, snow, or drizzle. However, when the warm air is connectively unstable, showers and thunderstorms may occur in addition to the steady precipitation. Abrupt temperature changes, like those characteristic of cold fronts, do not accompany the warm frontal passage. Instead, the temperature change is gradual. It starts increasing *slowly* with the approach of the front and increases slightly more rapidly with the passage. The dew point is normally observed to rise as the front approaches, and a further increase follows the frontal passage when the air in the warm sector is of maritime origin.

Cold Fronts

A cold front is a surface along which advancing cold air is displacing warm air. Cold fronts tend to move faster than other types of fronts and also tend to be associated with the most violent weather. The cold air wedges beneath the warm air, lifting it to the surface and often producing frontal clouds and precipitation.



Side View of a Typical Cold Front

Cold fronts tend to be associated with cirrus clouds well ahead of the front, strong thunderstorms along and ahead of the front, and broad areas of clouds immediately behind the front.

In advance of cold fronts, the reason the clouds are cumulus is because air is being rapidly raised to its condensation level. Cumulus clouds are typical of warm air, but also a sign of unstable air. Towering cumulus, cumulonimbus, stratocumulus, and nimbostratus are associated with the passage of a cold front. After passage, these cloud forms may prevail for several hundred miles with the slow-moving cold front. Very rapid clearing conditions are associated with the fast-moving cold front after passage. Well back in the cold air in both types of cold fronts, the only clouds normally found are fair-weather cumulus.

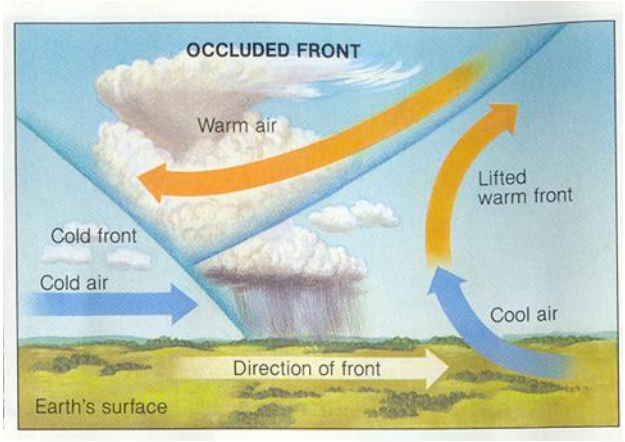
Cold fronts usually bring cooler weather, clearing skies, and a sharp change in wind direction. Showers and sometimes thunderstorms occur as a cold front passes. Continuous precipitation is observed for some hours after passage of a slow-moving cold front. Showers and thunderstorm activity of short duration will occur with the passage of a fast-moving cold front, followed by very rapid clearing conditions. Cold fronts usually bring cooler weather, clearing skies, and a sharp change in wind direction.

Stationary Fronts

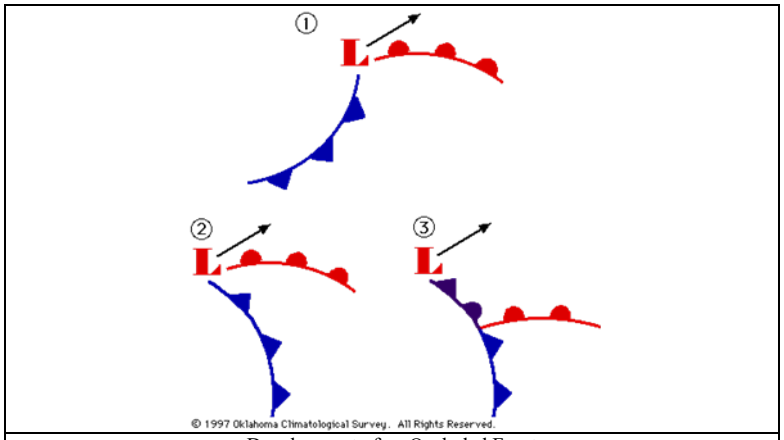
Stationary fronts are fronts that do not move or barely move. Stationary fronts, behave like warm fronts, but are more quiescent. Warm air is continuously lifted up the frontal surface which results in cloudiness and precipitation, possibly even extended periods of precipitation. Many times the winds on both sides of a stationary front are parallel to the front. Typically stationary fronts form when polar air masses are modified significantly so as to lose their character (e.g., cold fronts which stall). Stationary fronts eventually weaken and dissipate.

Occluded Fronts

Occluded fronts are formed when three rather than two air masses meet. Because cold fronts move faster than warm fronts, on occasion a cold front can catch up to and overtake their related warm front. When they do, an occluded front is formed.



Occluded fronts are indicative of mature storm systems (i.e., those about to dissipate). The most common type of occlusion in North America is called a cold-front occlusion and it occurs when the cold front forces itself under the warm front. The weather ahead of the cold occlusion is similar to that of a warm front while that along and behind the cold occlusion is similar to that of a cold front.



Development of an Occluded Front

Because the occlusion is a combination of a cold front and a warm front, the resulting weather is a combination of conditions that exists with both. Ahead of a cold-type occlusion, as the warm air is lifted, all clouds associated with a warm front are found producing typical prefrontal precipitation extensively for a distance of 250 to 300 miles. Typical cold front weather is found throughout the narrow belt in the vicinity of the surface front. However, the thunderstorms are less intense than those of a typical cold front. This occurs because the source of warm air has been cut off from the surface, and the energy received comes only from the warm air trapped aloft. Instability showers often follow the cold front when the cold air is unstable. The most violent weather occurs on the upper front for a distance of 50 to 100 miles north of the northern tip of the warm sector.

After the occlusion has passed, the weather usually clears rapidly. The weather associated with the warm occlusion is very similar to that of the cold occlusion. With the warm occlusion, the high-level thunderstorms associated with the upper cold front develop quite some distance ahead of the surface front (up to 200 miles), and the weather band, in general, is wider (up to 400 miles). The air behind the cold front, flowing up the warm frontal surface, causes cumuliform-type clouds to form. In this area, precipitation and severe icing may be found. The most violent weather occurs on the upper front, 50 to 100 miles north of the northern tip of the warm sector.

Predicting Weather

If you study clouds carefully and observe how they change with the weather, you will see some very consistent patterns. Before radio, television or newspaper forecasts were readily available, people whose livelihoods depended on the weather (like sailors or farmers) often used the clouds as a indicator of what might happen.
Low pressure weather systems especially have a prescribed sequence of clouds. After a spell of clear weather, usually the first signs of a change coming are high wispy **cirrus** clouds. If you check you barometer, it is probably high and about ready to fall.

These high clouds often thicken and may fill the sky. When they do, they are called **cirrostratus**. Cirrostratus is a white milky ice-crystal cloud. A halo may appear around the sun or moon with cirrostratus clouds. Usually precipitation is 12 to 24 hours away when the sky becomes completely covered by cirrostratus.

The clouds often then continue to lower and thicken. **Altostratus** or middle layer clouds are often next. They are gray or bluish gray in color. The sun often is still dimly visible through altostratus clouds but gradually fades. Precipitation is often just hours away. Winds freshen from the east or southeast.

When rain or snow begins, the clouds are **nimbostratus** (Remember: nimbus means rain). Precipitation is usually steady and light to moderate.

Sometimes, especially in spring, heavy downpours and thunder may signify some imbedded **cumulonimbus** in the nimbostratus clouds.

Clouds continue to lower during the precipitation. When the air becomes saturated near the ground, fog may form. This is usually a sign you are near a warm front. If the precipitation ends, winds shift to the south or southwest and the skies brighten; the warm front is likely to have passed. The air in the warm sector of storms is usually hazy, unseasonably warm and humid.

Darkening skies and freshening winds are usually the signs that the next change associated with a storm passage, the cold front is approaching. **Cumulonimbus** clouds (refer to photo above) often precede or accompany the cold front and bring showers and thunderstorms.

If you tap your barometer, you should see pressures now near its lowest point. A gusty wind shift to the northwest usually signifies the passage of the cold front. Typically, the pressure begins to rise rapidly while temperature and humidity drop and skies partially clear.

Cumulus clouds often follow generally signifying fair weather.

If the air is cold and winds are strong and gusty, cumulus clouds may fill the sky during the day. These are called stratocumulus.

Sprinkles or flurries can fall from these clouds if the air is sufficiently unstable and moist. Eventually winds diminish, the pressure rises slowly, and blue skies dominate, signifying high pressure is approaching.
After a day or so of fine weather, **cirrus** clouds may appear signifying the approach of the next weather system.

Closing Thoughts

Weather is a part of your life everyday, whether you are home, sitting in a classroom, on vacation with your family, or spending time with friends. Certainly weather has an impact. Is the sun shining? Are there clouds in the sky? Is rain on the way? After completing this unit and becoming familiar with cloud formations and their impact on weather, you can begin making your own weather predictions.