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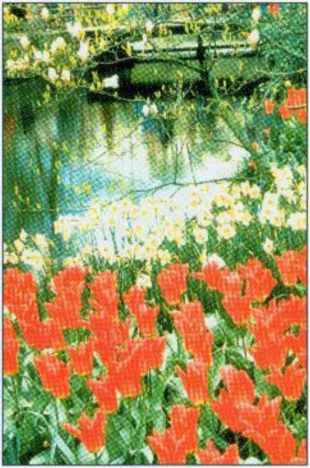


Chapter 1
God Created

God used His infinite wisdom to create this earth. From the smallest to the largest feature of creation, He displays His intelligence, love, and careful attention to detail.

God placed the moon 240,000 miles (384,000 km) away from the earth — exactly the right distance to cause small tides in the ocean. If the moon were a little closer, it would cause severe tides and flooding. If it were only 50,000 miles (80,000 km) away instead of 240,000 miles, the tides would cover most of the continents twice a day. If the moon were farther away, much of the ocean would become heavily polluted. Tides mix the ocean water. The mixing helps to keep the oceans fresh by exposing more of the water to sunlight and by dispersing pollution. The amount of water in the ocean is important as well, because the oceans are large enough to dilute pollution.

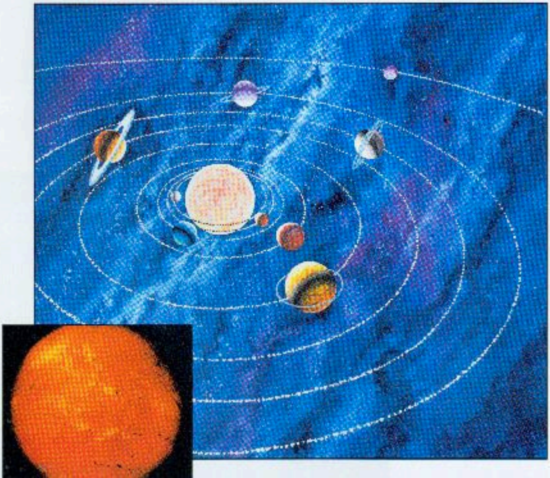
Did you know that the sun is 400 times the size of the moon, and its distance is 400 times the distance of the moon from the earth? That is why the sun and moon, the greater and lesser lights of Genesis 1:16, look the same size in the sky.

The earth spins on its axis at just the right speed — once around every day. If it spun slower, the light side would be too hot for life and the dark side would be too cold. If the earth spun any faster it would cause fierce winds to blow.

If the earth's tilt were smaller, the higher latitudes would be too cold and an ice age would develop. If the tilt were greater, surface temperatures would fluctuate wildly, more so than today, making the climate more unstable. The tilt gives us our summer growing season. God has provided a time for us to grow our food everywhere on earth, except for the North and South Poles.

God placed just the right amount of water vapor and carbon dioxide in the atmosphere. Our ocean is the right size to maintain the proper balance of water vapor in the atmosphere. These gases cause the earth to act like a giant greenhouse. If there were much less of these gases, the earth would be too cold. Although these invisible gases make up about 0.1 percent of the atmosphere, they cause the earth to be about 60°F (35°C) warmer. If there were much more of these gases, the earth would be too hot.

God put exactly the right amount of oxygen in the atmosphere. The atmosphere is composed of about 21 percent oxygen, 78 percent nitrogen, 0.9 percent



God placed the earth exactly the right distance from the sun — 93 million miles. If it were just a little closer to the sun, it would be too hot for life to exist. If the earth were farther away, it would be too cold and all water on earth would be frozen.

argon, and about 0.15 percent water vapor and carbon dioxide. If there were more oxygen, the processes in our bodies would react too fast. More oxygen would cause fires to burn so quickly that they would provide less sustained warmth and more danger. Forest fires would rage completely out of control. If there were less oxygen in our atmosphere, processes in our bodies would operate too slowly.

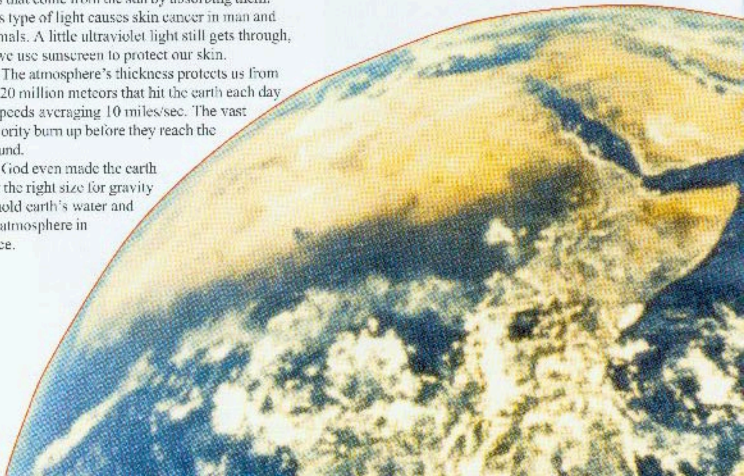
The oxygen level also is responsible for the amount of ozone in the stratosphere. Ozone protects us from most of the dangerous ultraviolet rays that come from the sun by absorbing them. This type of light causes skin cancer in man and animals. A little ultraviolet light still gets through, so we use sunscreen to protect our skin.

The atmosphere's thickness protects us from the 20 million meteors that hit the earth each day at speeds averaging 10 miles/sec. The vast majority burn up before they reach the ground.

God even made the earth just the right size for gravity to hold earth's water and the atmosphere in place.

Our world was specially created with design and purpose. In many other ways, Jesus made sure that this world would be a good home for us. For those who choose to listen, all creation shouts of His wondrous works and His love:

> *For the invisible things of him from the creation of the world are clearly seen, being understood by the things that are made, even his eternal power and Godhead; so that they are without excuse (Romans 1:20).*

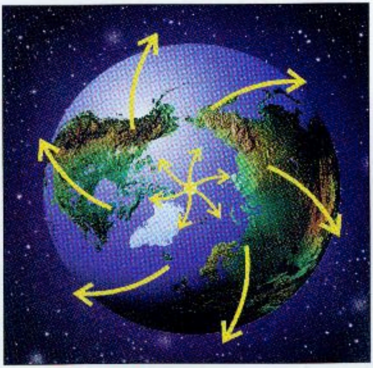


Chapter 2

What Causes Weather

Weather is the momentary condition of the air. Besides temperature and precipitation, it includes wind direction and wind speed, visibility, the amount of water vapor, air pressure, cloud conditions, and air quality. Precipitation is moisture that falls from the sky in the form of rain, freezing rain, snow, hail, or drizzle. Air quality is determined by how much dust, haze, or pollution is in the air.

The weather also depends on the latitude and how close to the ocean you are. During winter in the Northern Hemisphere, it is usually very cold in Saskatchewan, Canada, while in Texas the weather is mild. Summer temperatures are cooler in northern Europe than in southern Europe. It makes a difference whether you live in Seattle, Washington, close to the ocean, or in Bismarck, North Dakota, far from the ocean at the same latitude.



Coriolis Force

As the earth spins toward the east, the air flow in the Northern Hemisphere tends to veer to the right and in the Southern Hemisphere to the left.

The Weather Engine

The sun is the ultimate cause of weather. As sunlight enters the atmosphere its rays are either absorbed by the air or reflected back to space from the white clouds. Sunlight that makes it to the ground is both absorbed and reflected. Most of the reflected light goes back into space. The sunlight absorbed at the earth's surface heats the ground. As the surface warms, it heats the atmosphere above it.

The ground and atmosphere continually lose heat by *infrared radiation* (invisible rays that cool the land at night). Many of these infrared rays are absorbed by the atmosphere, but those that escape into space cause the cooling. Clouds act like a blanket to keep the earth warmer at night. They absorb most of the infrared radiation and redirect some of it back to the ground. As a result, the ground and air below the clouds do not cool off much at night.

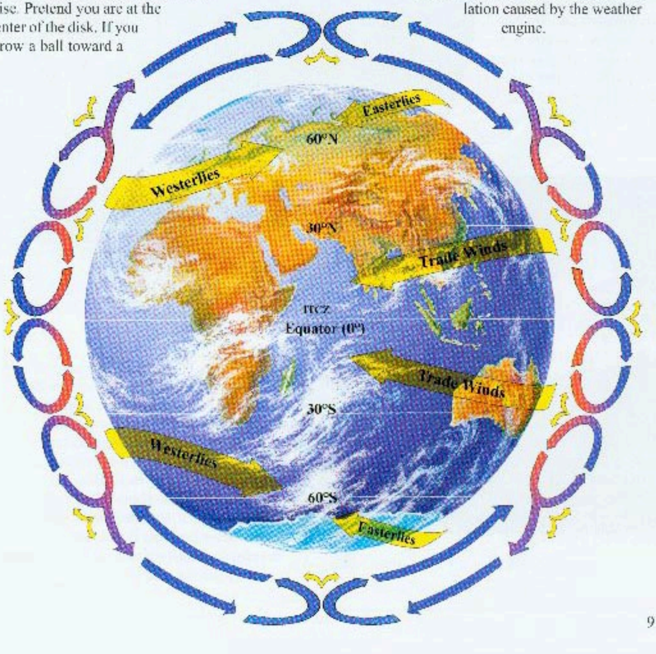
The infrared radiation cools the earth at night. When the sun comes up, the sunshine warms the ground and air. This is why the air cools at night and warms during the day. If the days are long and the nights short during summer, more heat is gained by sunshine than is lost by infrared radiation in a 24-hour period. So temperatures warm as summer approaches. It works the opposite in winter. The shorter days and longer nights result in more loss of heat in a 24-hour period. As winter comes, temperatures become colder.

The difference between daytime sunshine and night-time infrared cooling also causes temperature differences between the tropics and polar latitudes. These temperature differences cause an air pressure change, which pushes the earth's winds. Air blows from high pressure to low pressure. For example, the air inside a tire is at a higher pressure than the atmosphere. There are more air molecules per cubic inch or cubic centimeter in the tire than in the atmosphere. So when you loosen the valve, the air flows out of the tire. It works the same way in the atmosphere.

Because of the earth spinning on its axis, air flow in the atmosphere is more complicated. The spin causes air to move to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. This deflecting force on air is called the Coriolis force. As air blows from high to low pressure, the Coriolis force causes it to circulate in a spiral around the low pressure center. The air spirals counterclockwise around a low center in the Northern Hemisphere and clockwise in the Southern Hemisphere. Because the air is spiraling towards the center of the low, it is forced upward, forming clouds and precipitation.

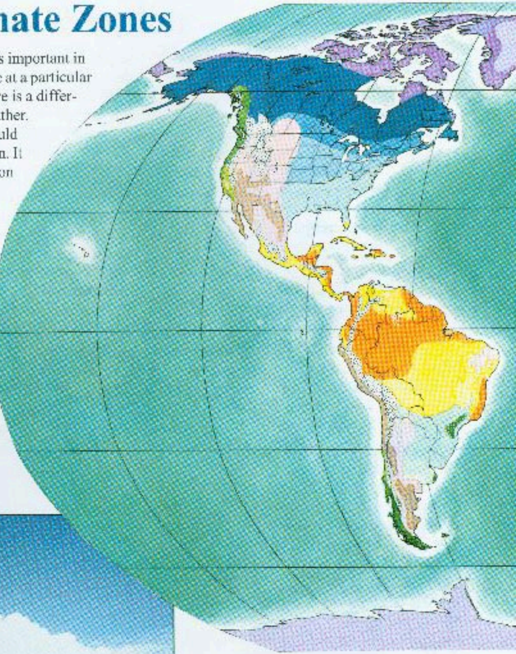
The Coriolis force in the Northern Hemisphere is like a disk rotating counterclockwise. Pretend you are at the center of the disk. If you throw a ball toward a target on the edge of the disk, the ball will miss to the right. It will appear that the ball was deflected to the right. What really happened was that as the ball reached the edge, the disk rotated to the left underneath the ball. It works the same in the atmosphere as the earth rotates.

Air generally rises at the equator. From there it spreads north and south. Air sinks at about 30° latitude. At that latitude it hits the ground and is forced both north and south. The air spreading back toward the equator forms a closed circulation. Two other closed circulations are found in the middle and high latitudes of each hemisphere. The earth has a total of six circulations. This is the planet's average or general circulation caused by the weather engine.

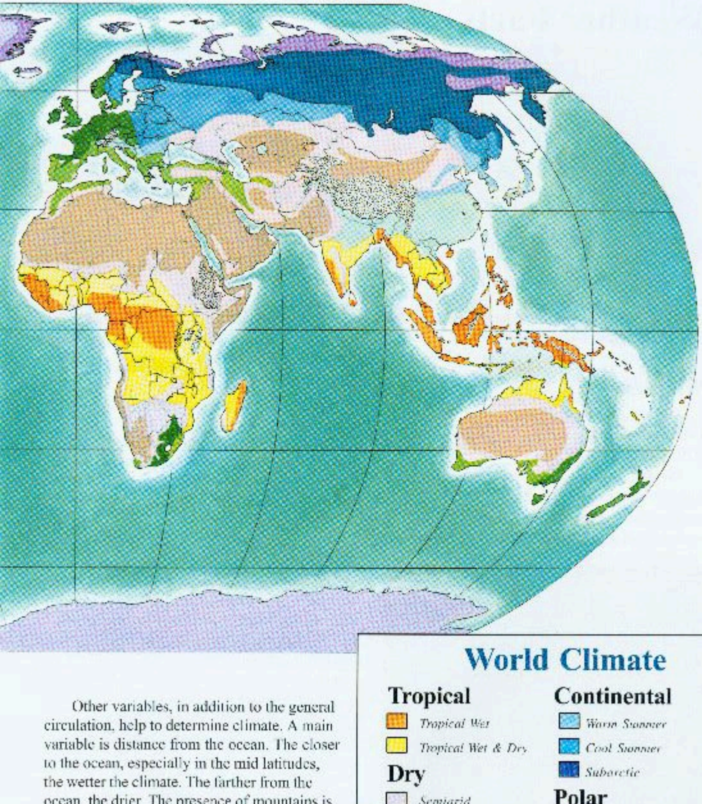


World Climate Zones

The general circulation is important in determining the climate at a particular point on the earth. There is a difference between climate and weather. Climate is the weather we would normally expect at any location. It is the average weather condition for a particular place at a particular time. In Death Valley, California, for example, the climate is very hot and dry during the summer. In Fairbanks, Alaska, the winters are very cold and the summers pleasantly warm. By knowing the climate, we can plan our lives better. If we know what to expect, we can be safe and comfortable even in a harsh climate.



Because of the general circulation, each place on earth experiences a different climate. Where the air generally rises, lots of precipitation is present. Sinking air, on the other hand, brings dry air downward from high in the atmosphere. As a result, it is very wet near the equator where the air rises. These are our tropical rain forests. Many of the earth's deserts are at 30° latitude. This is why the great Sahara Desert is almost rainless. The mid latitudes are much wetter than at 30° latitude and the poles are cold and mostly dry.



Other variables, in addition to the general circulation, help to determine climate. A main variable is distance from the ocean. The closer to the ocean, especially in the mid latitudes, the wetter the climate. The farther from the ocean, the drier. The presence of mountains is also another variable. Mountains are cooler and wetter. Upwind from a mountain range is wetter, while downwind it is drier. The general circulation, land-ocean distribution, and mountains all cause a complicated climate pattern.

World Climate

Tropical

Tropical Wet

Tropical Wet & Dry

Dry

Semiarid

Arid

Mild

Marine West Coast

Mediterranean

Humid Subtropical

Continental

Warm Summer

Cool Summer

Subarctic

Polar

Tundra

Ice Cap

High Elevations

Highlands

Uplands

Weather Facts

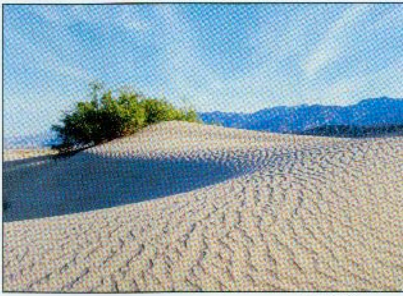
Hottest

The hottest temperature ever recorded was 136.4°F (58°C). This reading was taken in the shade at Azizia, Libya, September 13, 1922. Azizia is just north of the Sahara Desert.

Death Valley, California, is a close second. In 1913 it reached 134°F (56.7°C).

In 1889 Queensland, Australia, soared to 127.6°F (53.1°C).

The hottest place in the world is Dallol in Ethopia. It is on the edge of the Sahara Desert and has an *average* annual temperature of 93.3°F (34.4°C).



Death Valley.

Windiest

The highest recorded surface wind speed was a tornado in Texas. It was measured at 280 mph (450 kph).

On Mount Washington, in New Hampshire, a gust of wind was recorded at 231 mph (371 kph).

The George V Coast in Antarctica has recorded winds of 200 mph (320 kph).

Inside Mt. Waialeale crater on Kauai, Hawaii. It rains 365 days a year.

Strangest

We've all heard the expression, "It's raining cats and dogs." Well, on June 16, 1939, in Trowbridge, England, it actually "rained" tiny frogs. Strong winds had picked them up from nearby ponds and they fell back to earth with the rain.

Wettest

Although Mt. Waialeale has the highest yearly average rainfall, 460 inches (1,168 cm) a year, Cherrapunji, India, holds the record for any one year. Cherrapunji is affected by the monsoon, so it receives much summer rainfall and little in the winter. During the month of July 1861 it rained 366.14 inches (930 cm); the total for the year was a whopping 905.12 inches (2,299 cm)!

The largest recorded amount of rain to fall in one day was 73.62 inches (187 cm) at Cilaos La Reunion. In the United States, Alvin, Texas, received 43 inches (109 cm) of rain in one day. That is more rain than most places in North America receive all year.

The largest amount of rainfall in one hour was 12 inches (30 cm) in Holt, Missouri, and at Kilauea Sugar Plantation, Hawaii.

Coldest

The coldest temperature ever recorded in the world was -129°F (-89°C). It was measured July 21, 1983, at Vostok on the Antarctic Ice Sheet at 11,200 feet (3,400 m) above sea level. At that temperature carbon dioxide can freeze to dry ice.

Siberia has the second coldest record. Their record low is only -90°F (-68°C). The coldest temperature ever recorded in North America was -81°F (-63°C) at Snag, Yukon Territory, Canada.

Did you know that fresh snow reflects about 90 percent of the solar radiation (heat and light energy) back into the atmosphere? The snow surface receives so little heat the air above it stays cold.

Siberia.

Lowest

The lowest air pressure on earth probably occurs at the center of a tornado. It is doubtful if it could ever be measured. It would be very difficult to place a barometer at the center, and if it could be done the winds would no doubt destroy it.

Typhoon Tip had the lowest air pressure ever recorded; it was 25.69 inches (65.3 cm) on October 12, 1979.

Deepest

The snowfall on Mt. Rainier, Washington, in the 1971–72 season was 93.5 feet (28.5 m) or 1,122 in. This is the U.S. snow season record.

In 1921, 6.3 feet (1.9 m) of snow fell at Silver Lake, Colorado, in just 24 hours.

London, England, recorded snowdrifts of 15 feet (4.6 m) in 1881.

Fastest

What was probably one of the fastest temperature changes happened in Spearfish, South Dakota, on January 22, 1943. At 7:30 in the morning the temperature rose 49°F (27°C) in just two minutes.

Adélie penguins basking in the Antarctic sunshine.

Driest

Two of the driest areas of the world are northern Chile and the eastern Sahara Desert. Most years they do not receive any rainfall. In fact, Calama, Chile, didn't have a drop of rain from 1570 to 1971. That's 400 years without rain!

Did you know that the top of the Antarctic ice sheet normally receives only an inch (2.5 cm) of water in the form of snow each year? In fact, it is called a polar desert. Remember that Antarctica is a continent of land layered with ice. Where do you think its 10,000 feet (3,050 m) of ice could have come from, if the precipitation is this low? (See pages 68–69.)

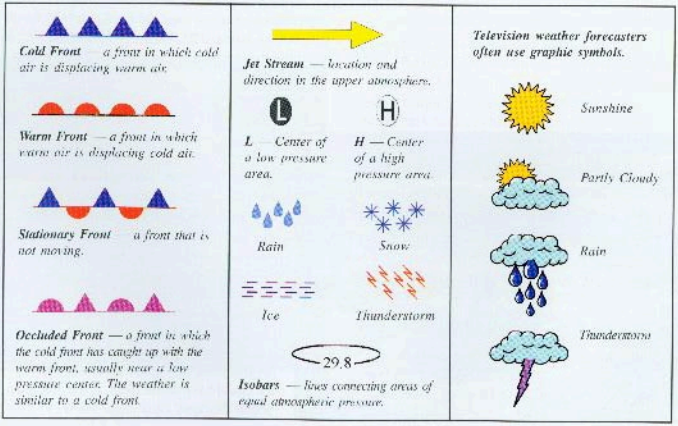
How to Read a Weather Map

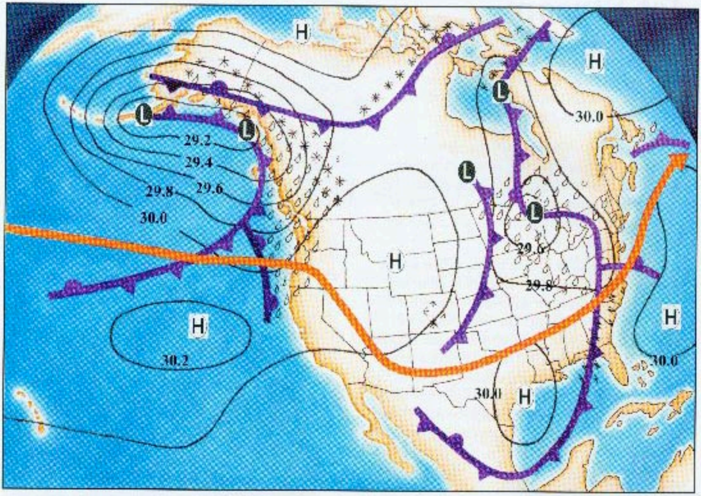
If you watch the weather on TV or read a newspaper's weather report, you will usually see a weather map displayed. This map will have low and high pressure centers with lines drawn around them. Before the map can be drawn, however, weather observations at the same time must be taken from all over the earth.

There are two types of weather observations. One type is the surface observation. Each weather station takes measurements of temperature, dew point, clouds, precipitation, pressure, and wind speed and direction. These are sent out by computer to other stations at least once an hour. The second type of observation is the upper air observation. This is done by weather balloons and taken twice a day. The instrument on the balloon measures the temperature, dew point, and pressure in the atmosphere up to 100,000 feet (30,500 m). A special radar tracks the balloon and provides wind direction and speed. All these observations are then plotted on maps. Weather maps used to be drawn by hand but now computers draw them.

On a surface map, lines connecting stations with equal pressure are drawn. From these lines we find where the low pressure and high pressure centers are. On the map you will see the location of high pressure centers labeled with "H," and low pressure centers labeled with "L." High pressure areas are generally good weather areas, except in winter the temperatures may be cold, like in an Arctic high that moves southward from Canada or Alaska. Low pressure areas are generally areas of stormy weather.

You will also see weather fronts on the map. A front is a boundary between air of different temperature and moisture content. If the front is not moving it is called a stationary front and is shown by a line with alternating triangles and semicircles. If the cold air, which is usually to the north or west, is displacing the warm air, it is a cold front and is labeled by a line with triangles. The triangles are drawn pointing in the direction the cold air is moving. If warm air is pushing out cold air, it is a warm front. A warm front is shown





Surface weather map on October 23, 1996.

by a line with semicircles, the rounded part pointing in the direction of movement, which is usually northward.

Using weather observations, the locations of all the fronts on a weather map, and the jet stream, the weatherperson can now make a forecast. From studying the atmosphere and the many scientific processes that occur, meteorologists have developed equations. These equations are fed into one of the world's fastest computers and projected into the future. After millions of computer operations, the position of the jet stream, the fronts, and the pressure centers are estimated in the future. This information is plotted on forecast maps at big weather centers and sent all over the world to smaller weather stations.

The weatherperson at each weather station receives lines on a map that represent the future weather pattern. He or she must then interpret these lines for their area. Over the years weather maps have improved. They are not perfect, however. Meteorologists do not know enough about the atmosphere, nor do they have enough observations. They need bigger and faster computers. So the weather maps still have to be interpreted. Even if the weather maps were perfect, it would be difficult to forecast the exact weather for their specific area. A weatherperson works from lines on the map, radar, and satellite pictures to predict temperature, precipitation, wind, and cloud conditions. They also issue advisories, watches, and warnings. Many times forecasting is easy; sometimes it is difficult. That explains why weather forecasts are sometimes incorrect.

Memory Tip: A science teacher in southern California taught his students how to remember the difference between a cold and warm front. Think of the triangles as icicles and the semicircles as blisters.