CHAPTER



Weather Maps

WORDS TO KNOW		Ň
air mass	front	source region
anticyclone	maritime air mass	station model
arctic air mass	mid-latitude cyclone	stationary front
cold front	occluded front	tropical air mass
continental air mass	polar air mass	warm front
cyclone	polar front	

This chapter will help you answer the following questions:

- **1** How do we identify air masses?
- 2 In what ways do mid-latitude cyclones and anticyclones influence our weather?
- **3** What are the different types of weather fronts?
- **4** Why do cyclones form?
- S How can many forms of weather data be shown on the same maps?
- 6 How do weather maps help meteorologists?

WEATHER FORECASTING

4: 2.1c 4: 2.2c

"Everybody talks about the weather but no one does anything about it." This statement comes from the author Mark Twain. It means that while weather affects us, we cannot change the weather. For many centuries, people depended on their limited understanding of weather to forecast weather events. "Red sky at night, sailors delight. Red sky in the morning, sailors take warning." These statements are based on the observation that a buildup of clouds in the morning is common before a storm. However, observations at one location may not give enough information to make forecasts accurate for more than a few hours into the future.

Weather forecasting improved near the end of the nineteenth century. The telegraph and radio increased communication between areas. People could learn about weather conditions in other areas. At the same time, the science of meteorology began to explain how regional weather systems develop.

In the second half of the twentieth century, meteorologists began to use computers, which quickly analyzed huge amounts of data. Meteorologists then had more data and mathematical models of the atmosphere. They hoped that these advances would greatly extend their forecasting ability. Some expected accurate weather predictions for weeks or even months into the future. Although forecasting has certainly become better, the level of accuracy they hoped for has not been reached. However, computer analysis has greatly improved short-term weather forecasts. In addition, weather satellites and regional radar allow meteorologists to see the broad scope of weather systems.

Scientists have learned that nature is not as predictable as they had hoped. The atmosphere is a complex, fluid system. Within that system, tiny changes grow to major importance through time. The atmosphere and its motions are too complex to permit accurate long-range forecasting. Visit the following Web site to see the current weather radar for the United States: <u>http://www.intellicast.com/Local/Default.aspx?redirectUrl=/Local/Weather.aspx&country=United%20States</u>

WHAT ARE AIR MASSES?

4: 2.1e, 2.1f, 2.1h When a large body of air stays over a region, it takes on the temperature and humidity characteristics of the region. An **air mass** is a body of air that is relatively uniform in temperature and humidity. Meteorologists describe air masses by their temperature and humidity. These variables influence other weather variables. For example, temperature and humidity affect air density. Where the air is cold and dry, barometric pressure is likely to be high. The air-pressure gradient affects winds. Where the gradient is steep, the winds are strong. Humidity affects cloud cover and precipitation. Therefore, when meteorologists describe an air mass by its temperature and humidity, they suggest other weather variables as well.

Source Regions

If you know the temperature and humidity of an air mass, you can infer the area over which it originated. This is the **source region**. For example, central Canada is most likely the source region of a cold, dry air mass moving from west to east across New York State. In central Canada, there is relatively little open water and the temperatures are cooler. A warm, moist air mass most likely originated over the South Atlantic Ocean or the Gulf of Mexico. This kind of air mass is likely to bring lower air pressure with clouds and precipitation. Figure 22-1 shows the source regions for air masses that move into the United States.

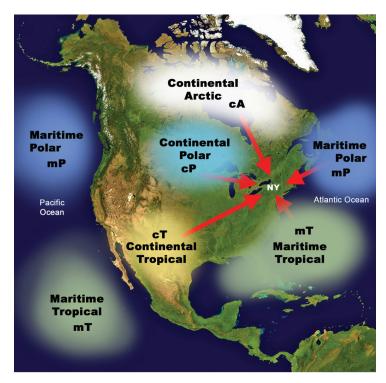


FIGURE 22-1. This map shows the principal source regions for air masses that affect New York State. Note that the characteristics of an air mass are determined by the prevailing weather conditions in the region over which it originates.

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DESCRIBING HUMIDITY The terms *continental* and *maritime* describe the humidity of an air mass. **Continental air masses** have relatively low humidity. They originate over land. **Maritime air masses** have relatively high humidity. They originate over the ocean or another large body of water. (The term *maritime* refers to the oceans or human activities associated with oceans.)

DESCRIBING TEMPERATURE The terms *tropical, polar,* and *arctic* define the temperature characteristics of an air mass. **Tropical air masses** are warm. They originate close to the equator. Polar **air masses** are cool. They originate near one of Earth's poles. When an especially cold air mass that originated in the Arctic enters the United States from Canada, meteorologists call this an **arctic air mass**.

Air Mass Codes

Each type of air mass has a unique two-letter code that is made of a lowercase letter followed by a capital letter. These codes are listed in the *Earth Science Reference Tables*. Five air mass types are listed below along with their most common North American source regions.

- mT *maritime tropical:* A warm, moist air mass that probably came from the South Atlantic Ocean or the Gulf of Mexico.
- cT *continental tropical:* A warm, dry air mass that may have originated in the deserts of the American Southwest or the land regions of Mexico.
- mP *maritime polar:* A cold, moist air mass that most likely moved in from the northern parts of the Atlantic or Pacific Ocean.
- cP *continental polar:* A cool and dry air mass that most likely entered the United States from Canada.
- cA *continental arctic:* An unusually cold and dry air mass from Arctic Canada.

Note that the first letter, indicating humidity, is lowercase, while the second letter, which designates temperature, is capitalized. These codes are also shown in Figure 22-1 on page 523.

STUDENT ACTIVITY 22-1 —IDENTIFYING AIR MASSES

6: MODELS 2 6: PATTERNS OF CHANGE 5 Use weather maps from a newspaper or from the Internet to identify different air masses entering the United States and infer their source regions. You may decide to use temperature isoline (isotherm) maps to help you locate regions with relatively uniform temperatures.

WHAT ARE MID-LATITUDE CYCLONES AND ANTICYCLONES?

4: 2.1c, 2.1e, 2.1h 4: 2.2b The term *cyclone* has many meanings, even in meteorology. In general, a **cyclone** is a region of relatively low atmospheric pressure. Hurricanes in the Indian Ocean are often called cyclones. It also is used as a synonym for tornado. Hurricanes and tornadoes are intense low-pressure weather events. In this chapter you will learn about **mid-latitude cyclones**. These are areas of low-pressure or storm systems, such as those that usually move west to east across the continental United States.

When air is heated or when moisture is added, the air becomes less dense. This results in lower barometric pressure and causes the air to rise. Rising air is part of heat flow by convection. Rising air pulls air from all sides into the low-pressure center.

A low-pressure system is a cyclone. A high-pressure system is the opposite of a low-pressure system. Therefore a high-pressure system is an **anticyclone**. Anticyclones usually bring clear weather. Within an anticyclone, cool, dry air descends and spreads over the surface. Anticyclones do not pull in air masses. A highpressure system is a single, spreading air mass that generally covers the surface with cool, dry, and stable fair weather.

Remember, while winds generally blow from high-pressure areas to low-pressure areas, the Coriolis effect makes them appear to curve along Earth's moving surface. Consequently, winds seem to curve to the right moving out of a high-pressure zone. Then they turn left into a cyclone. You will see this wind pattern around all mid-latitude cyclones in the Northern Hemisphere. (In the Southern Hemisphere, winds curve left when moving out of a highpressure zone and turn right into a cyclone.)

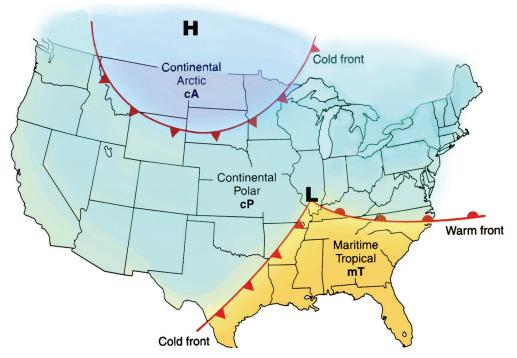
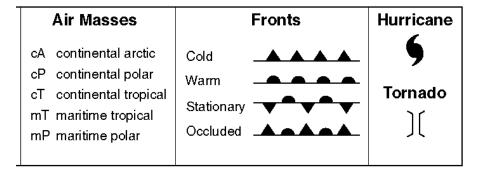


FIGURE 22-2. The three air masses on this weather map are separated by interfaces called fronts. The symbols on the frontal lines show the direction of wind movement, spreading outward from the high and converging in a counterclockwise circulation around the cyclone (low). The arctic air mass following the polar mass identifies this as a winter weather map.

Figure 22-2 is a weather map of the United States that shows the location of three air masses in the winter. The boundaries, or interfaces, where air masses meet are weather **fronts**. Fronts separate one air mass from another. Weather changes occur rapidly along fronts as one air mass replaces another. You will learn about the symbols on the fronts later. Remember that winds diverge from a high-pressure center and circulate counterclockwise as they converge into the center of the low. The triangles and half circles along the front lines indicate the direction in which the front is moving.

HOW ARE WEATHER FRONTS IDENTIFIED?

4: 2.1c, 2.1g, 2.1h Like other interfaces in nature, energy is exchanged along fronts. Weather changes generally occur along fronts. For example, stormy weather is usually associated with the passage of fronts and strong cyclonic systems. Meteorologists keep track of weather fronts as



they observe and forecast weather over broad regions. Meteorologists identify four kinds of weather fronts: cold fronts, warm fronts, stationary fronts, and occluded fronts.

Figure 22-3 from the *Earth Science Reference Tables* shows the standard symbols used to label fronts on weather maps. For example, triangular points on the south side of the front line represent a cold front moving south. The "swirl" symbol on the right side of Figure 22-3 is used to mark the center of a hurricane.

Cold Fronts

Cold fronts are so named because they bring cooler temperatures. Figure 22-4 is a three-dimensional view of a cold front. Because cold air cannot absorb as much moisture as warm air, it is also likely to be less humid. Cold and dry air is more dense than

FIGURE 22-4. When a cold front passes, cold, dense air wedges under warmer air, pushing it upward. The rising air often causes cloud formation and precipitation along the front. Following the passage of a cold front, the weather is cooler and usually dryer. On weather maps, cold fronts are labeled with triangles pointed to show the direction in which the front is moving.

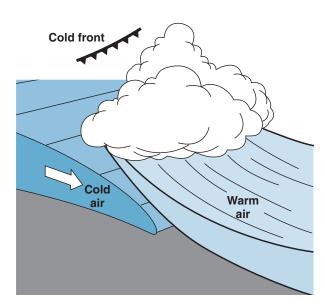


FIGURE 22-3. Weather map symbols from the Earth Science Reference Tables.



FIGURE 22-5. A bank of puffy cumulus clouds often announces an approaching cold front.

air that is warmer and more moist. Therefore, the denser cold air will wedge under the warmer air it is replacing and force the warm air mass to rise. Rising air expands and becomes cooler. If the warmer air mass being pushed up is humid, there will probably be cloud formation and precipitation along the cold front. Dark, puffy cumulus clouds such as those in Figure 22-5 are typical along cold fronts. Visit the following Web site to learn more about the different kinds of clouds: <u>http://asd-www.larc.nasa.gov/</u><u>SCOOL/cldchart.html</u>

Cold fronts pass quickly, usually in an hour or two. Precipitation tends to be brief. It is followed by clearing skies and falling temperatures. Cold air is more dense than warm air. Therefore, the passage of a cold front usually produces higher barometric pressure, as you can see in Figure 22-6. In the summer, cold fronts often bring thunderstorms and relief from hot, humid weather. In winter, the passage of a cold front usually results in crisp, clear conditions.

Warm Fronts

Just as cold fronts cause the temperature to fall, **warm fronts** bring warmer temperatures. Figure 22-7 is a three-dimensional representation of a warm front. Unlike the quick passage of cold

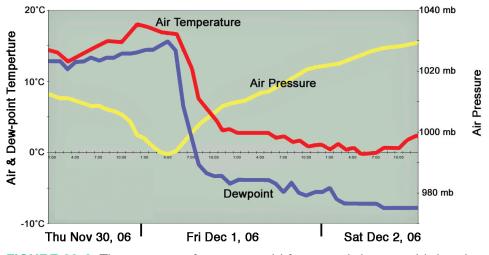
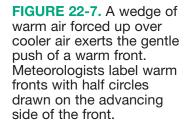


FIGURE 22-6. The passage of a strong cold front can bring a rapid drop in both temperature and dew point. Air pressure tends to decrease as the low-pressure center approaches and then increase quickly with the arrival of the cold air mass.

fronts, warm fronts may take a day or two to pass through. Warm air is lighter and less dense than cold air, so warm air does not have as much ability to push aside cold air. As a result, the warm air drags the cold air mass. Therefore, the warm front moves slower than the cold front. A wedge of warm air rides up and over the air mass it is replacing. You can predict the approach of a warm front when you see high, thin cirrus clouds that gradually become thicker and lower. As the warm front approaches, stratus clouds



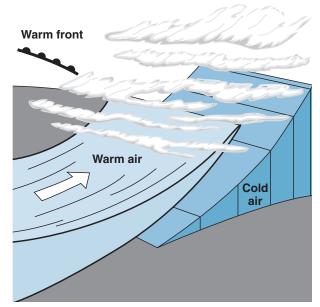




FIGURE 22-8. High thin cirrus clouds like these sometimes signal an approaching warm front.

cover the sky like a blanket. Figures 22-8 and 22-9 show clouds that may appear as a warm front approaches.

Rising air along the warm front often produces thick layered clouds and gentle but long-lasting precipitation. As the front passes, the temperature gradually increases. More humid conditions commonly follow the frontal interface, as well. Warm air is less dense than cool air. Therefore, atmospheric pressure generally decreases with the passage of a warm front. On weather maps, half circles along the front line indicate advancing warm air.

Look again at the weather map in Figure 22-2 on page 526. It shows two cold fronts and a warm front. The cold front that extends southwest from the low-pressure center is the advancing edge of a cold, polar air mass. The second cold front moving south



FIGURE 22-9.

As you learned in Chapter 5, strata are layers. Thickening stratus clouds like these often indicate an approaching warm front. from Canada defines an outbreak of especially cold arctic air. Meanwhile, circulation about the low is drawing in a warm air mass and slowly pushing a warm front to the north over the eastern seaboard.

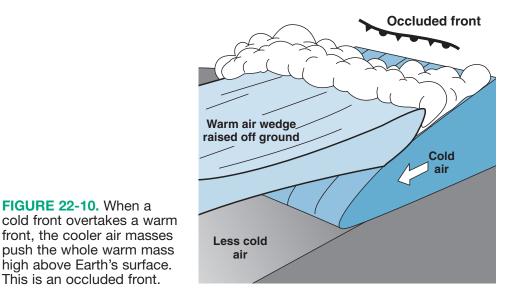
Occluded Fronts

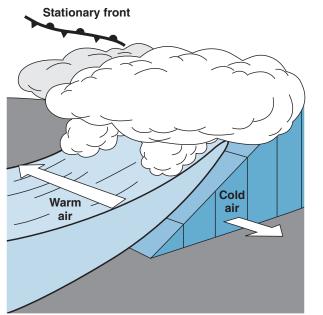
Because cold fronts move faster than warm fronts, a cold front sometimes overtakes a warm front. When this happens, the interface between warm and cold air masses is pushed off the ground and up into the atmosphere. The body of warm air is held up by two cooler air masses that merge beneath it. This is called an **oc-cluded front**, as shown in Figure 22-10.

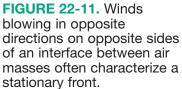
Passage of an occluded front produces cloudy weather. It may or may not bring precipitation. The warm air-cold air interface is isolated above the surface. Therefore, as an occluded front passes, people at ground level might not notice a change in temperature. On a weather map, alternating triangles and half circles show the direction in which an occluded front is moving.

Stationary Fronts

The word *stationary* means not moving. **Stationary fronts** can remain in one location, keeping skies cloudy for hours or even days. The eventual direction of movement of the frontal interface is dif-







ficult to predict. Therefore, temperature changes along the front are not as predictable as they are when a cold or a warm front passes through. Winds blow in opposite directions on either side of the front, as shown in Figure 22-11.

On a weather map, triangles and half circles are drawn on opposite sides of the front. A stationary front can become a warm front if it advances toward the side of the half circles. If the stationary front advances toward the triangles, it becomes a cold front.

The Polar Front

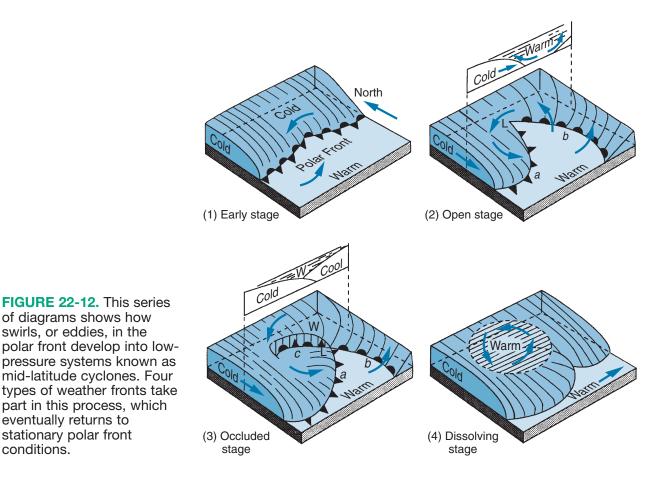
The **polar front** is the boundary between two great convection cells. You can see it on the Planetary Wind and Moisture Belts chart in the *Earth Science Reference Table* and Figure 21-15 on page 513. The polar front is also the most common path of the upper atmosphere polar jet stream. The jet stream begins the formation of mid-latitude cyclones and steers them across Earth's surface. When the polar front moves south, it advances as a cold front. When moving to the north, it becomes a warm front. In theory, the polar front is a continuous boundary. It circles Earth at the northern edge of the zone of prevailing westerly winds. However, the polar front is not very stable and it is often broken apart by cyclonic circulation.

In the summer, the polar front is usually located north of New York State. In warm weather, New York is more often affected by weather systems that develop along the subtropical jet streams at lower latitudes. However, in the winter, the global wind belts shift to the south. This brings the polar front closer to New York. Outbreaks of arctic air push the polar front southward through New York, bringing winter storms. In spring, the polar front returns to arctic Canada as summer weather patterns settle in.

HOW DO MID-LATITUDE CYCLONES EVOLVE?

4: 2.1e, 2.1f, 2.1g, 2.1h

th Low-pressure systems, or mid-latitude cyclones, often develop as swirls along the polar front. Figure 22-12 shows the evolution of a typical mid-latitude cyclone. This is a cycle in which the last stage returns to the beginning pattern. Not all lows develop in this clear sequence. However, the model is useful in understanding the structure and formation of mid-latitude cyclones. As they develop,



low-pressure systems seldom stay in one place. They generally move with the prevailing winds. In the United States, most lowpressure systems move across the country toward the east or northeast. For this reason, people sometimes say that if you want to know tomorrow's weather in New York, look at today's weather in the Midwest.

The early stage (1) shows the polar front as a stationary front. Winds blowing in opposite directions along the front create friction at the interface. A swirl starts to develop. In the open stage (2), winds moving toward the front change the stationary front to a cold front at a and to a warm front at b. The symbols for these two kinds of fronts match the key to front symbols in the *Earth Science Reference Tables*. The profile above diagram (2) shows cold air starting to push up the warm air mass. The third stage (3) is the occluded stage. The cold front is overtaking the slower-moving warm front. The profile above shows the warm air now pushed completely up above the front. In the dissolving stage (4), the warm air eventually loses its identity as it mixes with the air around it. Although this is the final stage of the mid-latitude cyclone, a stationary front is forming, which returns to first-stage conditions.

These diagrams do not show cloud formation and precipitation. Wherever warm, moist air is pushed upward, expansion and cooling cause clouds and precipitation. This occurs primarily along the fronts.

STUDENT ACTIVITY 22-2 —STAGES OF CYCLONIC DEVELOPMENT

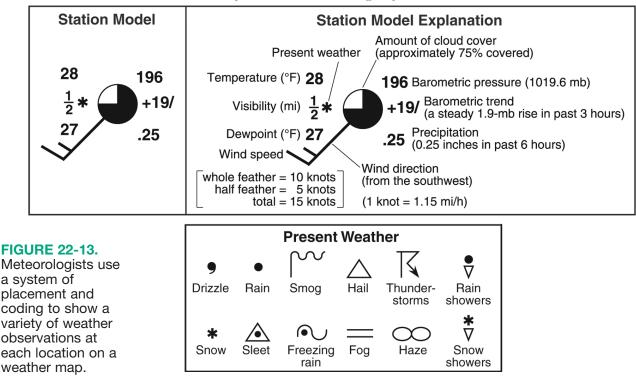
4: 2.1g 6: MODELS 2 6: PATTERNS OF CHANGE 5 Find weather maps from newspapers or other media sources to illustrate each of the four stages of cyclonic development shown in Figure 22-12. Label each stage with the correct name.

HOW ARE WEATHER DATA SHOWN ON WEATHER MAPS?

4: 2.1c, 2.1g To draw regional weather maps, meteorologists begin by collecting weather data. These data come from a wide network of landbased weather stations as well as from observations made on ships at sea. On the map, meteorologists group the information around a circle that indicates where the measurements were made. They use a standard system to display abbreviated weather data. This is called the **station model**. They indicate the time of these simultaneous measurements somewhere on the weather map. It is important to know how to interpret the information from the station models. Therefore, meteorologists follow certain rules.

Interpreting Weather Data

The first rule is that each weather variable has a unique position around a circle that indicates the location of the weather station. For example, barometric pressure in millibars is always indicated as a three-digit number above and to the right of the circle. The dew-point temperature in degrees Fahrenheit is always found at the lower left. Figure 22-13 is the weather station model printed in the *Earth Science Reference Tables*. It is common for weather stations to leave out some information, often because it is not important. However, the information shown will always occupy the standard position with respect to the station circle.



Key to Weather Map Symbols

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AIR TEMPERATURE Also known as dry-bulb temperature, air temperature on a station model is always recorded in degrees Fahrenheit. You can convert this temperature to Celsius using the temperature conversion scale on the same page of the *Earth Science Reference Tables* as the station model. (For example, the 28°F shown here is approximately -2° C.)

PRESENT WEATHER This indicates conditions such as precipitation or limited visibility. Symbols used to indicate the present weather are shown in the box below the station model. The United States Weather Service uses many more symbols than you will find in the *Earth Science Reference Tables*. The station model in Figure 22-13 shows that it was snowing at the time of the observations.

VISIBILITY The visibility is the greatest distance, measured in miles, at which objects can be identified. Precipitation, fog, or haze reduce visibility. In Figure 22-13, the half-mile limit of visibility is probably caused by snowfall.

DEW POINT You may recall that the dew point is the temperature at which the air would be saturated. Although dew point is a temperature, it used here as an indicator of the absolute humidity. In this station model, the dew point of 27°F is very close to the air temperature of 28°F. This indicates a high relative humidity, which is not surprising because it is snowing.

WIND DIRECTION A line connected to the circle indicates wind direction. Just as north is at the top of most maps, these symbols follow the standard compass directions. Think of the circle as the head of an arrow. In this case, the wind is blowing out of the southwest. (Wind, you will recall, is always named according to the direction from which it comes.) A line extending directly above the circle would indicate a north wind.

WIND SPEED The small lines at the end of the wind direction indicator are called feathers. Wind speeds are rounded to the nearest 5 knots. (As printed on the chart, 1 knot is 1.15 mph.) A half feather indented a short distance from the end of the wind direction line indicates a 5-knot wind. A 10-knot wind is shown

by a single feather at the end of the wind direction line. Two feather lines of equal length would indicate a 20-knot wind. This example shows a 15-knot wind. A circle surrounding the weather station dot indicates a calm area on the weather map. In this way, a calm area is not mistaken for a station in which the data is missing.

CLOUD COVER The amount of the circle that is dark indicates the portion of the sky covered by clouds. The example shows that the sky is mostly cloudy (75% covered). A circle that is all white in the center represents a clear sky.

AIR PRESSURE Air pressure is reported by a three-digit code number. Normal barometric pressure at Earth's surface is generally about 1000 millibars (mb). The first digit or the first two digits (9 or 10) of the air pressure reading are not shown. Furthermore, barometric readings are recorded to the nearest tenth of a millibar. Follow the rules below to interpret air pressure codes.

Rule 1: If the three-digit code is less than 500, add a "10" at the beginning and a decimal point before the last number. For example, if the barometric pressure were listed as 162, this would translate to 1016.2 mb.

Rule 2: If the three-digit code is more than 500 add a "9" before the number and a decimal before the last digit. For example 884 would become 988.4 mb. Do whichever procedure brings you closer to 1000 mb. If you do not get a value close to 1000 mb you have probably decoded the number incorrectly. The barometric pressure indicated in Figure 22-13, on page 535, is 1019.6 mb.

PRECIPITATION The amount of rain or snow in the past 6 h is sometimes shown. In Figure 22-13, the weather station has received an amount of snow equivalent to one-quarter of an inch (0.25) of rainfall. (Precipitation on a station model is always shown as its liquid water equivalent.)

BAROMETRIC TREND Rising air pressure usually brings clearing weather. Stormy weather is more likely if the atmospheric pressure is falling. The symbol "+" indicates rising air pressure and the symbol "-" indicates falling air pressure over the past 3 h. The number is in millibars and tenths of millibars. (You need to insert a decimal between the two numbers.) Next to the two-digit number is a line indicating the pattern of change. The data shown in Figure 22-13 indicates a steady rise of 1.9 mb in the last 3 h.

Note: There is a guide to the placement on this information, as well as how to interpret weather station data, in the *Earth Science Reference Tables*.

SAMPLE PROBLEMS

Problem 1 What weather conditions does the station model shown in Figure 22-14 indicate?



- **Solution** This station model indicates a temperature of 68°F and a dew point of 65°F. Hail is falling. The barometric pressure is 996.4 mb. Winds are from the east at 5 knots. There has been an inch of rain in the past 6 h. The sky is half (50%) covered with clouds.
- Problem 2 Draw a station model to represent the following conditions: Temperature and dew point are 62°F, and there is fog. Visibility is one-tenth of a mile. Winds are from the west at 10 knots. The air pressure is 1002.0 mb and it has gone down steadily by 0.9 mb in the past 3 h. Cloud cover is 25 percent.
- **Solution** Figure 22-15 shows these conditions. The fog symbol and visibility fraction can be shown above or below the wind direction line. The feather indicating wind speed can slant up or down. Otherwise the numbers and symbols must be in the positions shown in the figure.

$$\frac{1}{10} \underbrace{\stackrel{62}{\underbrace{62}}}_{62} \underbrace{\stackrel{020}{-09}}_{-09}$$
FIGURE 22-15.

- **Problem 3** Draw a station model to indicate a temperature of 20°C, a dew point of 11°C, and clear skies.
- **Solution** Temperatures on the station model are always shown in degrees Fahrenheit. The temperatures in Sample Problem 3 must be converted from Celsius to Fahrenheit before they are placed in their proper positions next to the station circle, as shown in Figure 22-16.

⁶⁸ 52 FIGURE 22-16.

STUDENT ACTIVITY 22-3 —CURRENT STATION MODELS

4: 2.1g

Create several station models to describe your local weather conditions as recorded at a particular time of day over a period of several days. (Your teacher will tell you how long.) You can gather weather data from online sources or from your own weather instruments.

HOW ARE WEATHER MAPS DRAWN AND USED?

4: 2.1c, 2.1g 6: PATTERNS OF CHANGE 5 You have already seen several weather maps used to illustrate wind patterns and air masses. In this section, you will learn how to draw a weather map. In addition, you will learn how weather maps are used to predict the weather. Weather includes many variables (temperature, air pressure, humidity, wind, sky conditions, and precipitation). Meteorologists find it useful to show many of these factors over a wide geographic area. A map that combines several weather variables is called a synoptic map because it shows a summary, or synopsis, of weather conditions.

Gathering Data

Remote sensing has become a standard observation technique available to meteorologists. Remote sensing is the use of instruments to gather information at a distance from the instrument. Radar images and photographs from satellites are good examples. You can access current satellite photographs, radar images, and other regional data on the Internet, through a local office of the National Weather Service, or the National Oceanic and Atmospheric Administration (NOAA) of the United States Government. Other organizations such as *The Weather Channel, Weather Underground,* and similar Web sites provide current online weather maps and images.

STUDENT ACTIVITY 22-4 — DRAWING WEATHER FRONTS

4: 2.1c, 2.1g 6: PATTERNS OF CHANGE 5

From the Internet, download and print a current satellite weather image of a part of the United States. On that image, label the centers of high- and low-pressure systems. Draw appropriate weather fronts using weather maps or the pattern of development you see. Label air masses by their two-letter codes. Use your drawing to predict tomorrow's weather at your location. One source of satellite images is the *National Oceanic and Atmospheric Administration:* <u>http://www.weather.gov/sat_tab.php?image5ir</u>

Using Weather Data

Professional meteorologists often have years of experience and access to more information than can be shown on a single weather map. For example, observations of the jet stream help them predict how weather systems will move. They can also use computers to access how weather changed in the past when similar conditions were in effect. Some of the most powerful computers ever built have been used to work with complex equations that represent the atmosphere. Meteorologists sometimes construct mathematical models of the dynamics (changing nature) of the atmosphere to find how far into the future accurate predictions can be made. Visit the following Web site to learn how to understand weather maps: <u>http://ww2010.atmos.uiuc.edu/(Gh)/guides/maps/home.rxml</u>

STUDENT ACTIVITY 22-5 —RELIABILITY OF WEATHER FORECASTS

2: INFORMATION SYSTEMS 1 6: PATTERNS OF CHANGE 5 Make a table to record the expected changes in weather conditions over a period of a week. See the sample shown below. You may add more weather factors if you wish. Each day, make your own ("My") predictions of how you expect the weather to change the following day. Also record how these changes are predicted in a particular news media source.

Name ____

Week of

	Monday		Tuesday		Wednesday		Etc
Changes In	My	Media	My	Media	My	Media	
Temperature							
Cloud cover							
Precipitation							
Winds							

The next day, circle any predictions that were incorrect and record your own predictions as well as the media predictions for the following day. Continue this procedure for at least a week.

How often do you differ from the media predictions?

What is the percentage of correct predictions for you and for the news source?

Drawing Weather Maps

Figures 22-17 A through D, on page 542, illustrate how weather data is transformed into a weather map. Diagram A shows selected weather station data. Diagram B shows isobars of air pressure. Diagram C shows isotherms of temperature. Diagram D is a weather system map. Note that isolines are drawn as if the numbers were located at the center of the circles. The pattern of a cyclone

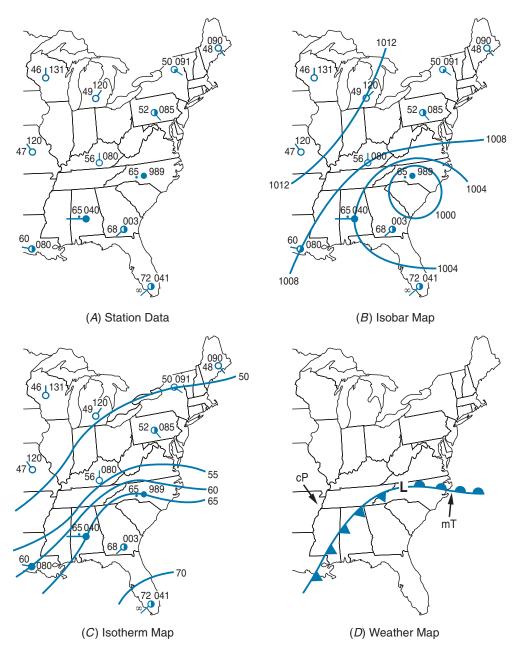


FIGURE 22-17. Drawing synoptic weather maps is a step-by-step process. (*A*) Weather data is collected from weather observers over a geographic region. The data can be used to draw a weather map. Next (*B*), the isolines of barometric pressure (isobars) are drawn based on the air-pressure data displayed at each station. (*C*) The temperature field is shown with isotherms. (*D*) The position of the low and the two weather fronts are based on wind direction and other data from the previous maps. Precipitation usually occurs along weather fronts.

(low-pressure system) is apparent from the data and from the circulation of winds around the North Carolina station. The changes in temperature and air pressure along with the winds and precipitation guide the placement of the cold and warm fronts.

Using Weather Maps to Make Predictions

Weather maps are an important tool used by meteorologists in forecasting weather. Figure 22-12 on page 533 shows how lowpressure systems generally develop. They mature and move across the United States from west to east, or toward the northeast. You can use current weather maps to make predictions of your local weather for the next day or two. Figure 22-18 is a weather map of the United States. Notice how this map can be used to make the following forecasts for these cities:

• *New York City* Rain will probably end as the warm front advancing northward passes through the city. Warmer weather and partial clearing will occur as a warm, moist air mass slides over New York. The density of warm, moist air is low; therefore, the barometric pressure will remain low.

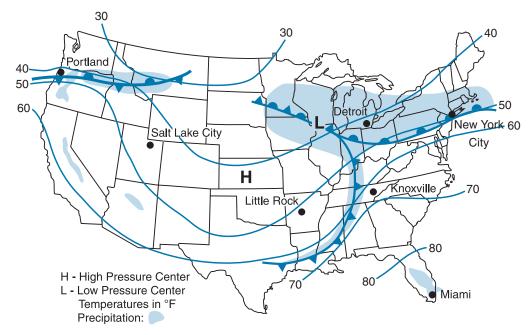


FIGURE 22-18. Meteorologists use a synoptic weather map to present information about weather conditions over a large region. The map may be used to make local weather forecasts for locations throughout the area.

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- *Knoxville* The cold front approaching from the west will bring rain, followed by cooler and clear weather. The temperature and humidity will then drop, and barometric pressure will rise as a cool, dry air mass moves in with the passage of the cold front.
- *Little Rock* Cool, dry weather is likely to continue. It will probably be a few days before the anticyclone (high-pressure system) that is building into the area no longer dominates local weather.
- Detroit The spell of rainy weather is likely to continue for another day or so until the low-pressure, storm system moves away to the east or northeast. Visit the following Web site to see animated weather maps that predict national weather for the next four days: <u>http://www.wunderground.com/modelmaps/</u> <u>maps.asp</u>

CHAPTER REVIEW QUESTIONS

Part A

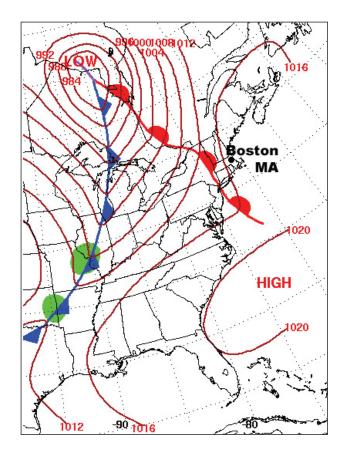
- **1.** Which type of air mass most likely formed over the deserts of the American Southwest?
 - (1) cT (3) mT
 - (2) cP (4) mP
- 2. A weather station model is shown below.



What is the barometric pressure indicated by this station model?

- (1) 0.029 mb (3) 1002.9 mb
- (2) 902.9 mb (4) 1029.0 mb
- **3.** From what direction do most weather systems move as they begin to affect New York State?
 - (1) northeast (3) southeast
 - (2) northwest (4) southwest

4. The weather map below shows a strong mid-latitude cyclone moving across eastern North America.



What are the most likely weather changes in Boston, Massachusetts over the next few hours?

- (1) increasing temperature and increasing air pressure
- (2) increasing temperature and decreasing air pressure
- (3) decreasing temperature and increasing air pressure
- (4) decreasing temperature and decreasing air pressure
- 5. Which description below best describes high- and low-pressure systems?
 - (1) A high-pressure system is a cyclone and a low-pressure system is an anticyclone.
 - (2) A low-pressure system is a cyclone and a high-pressure system is an anticyclone.
 - (3) A cyclone includes regions of both low and high pressure.
 - (4) An anticyclone includes regions of both low and high pressure.

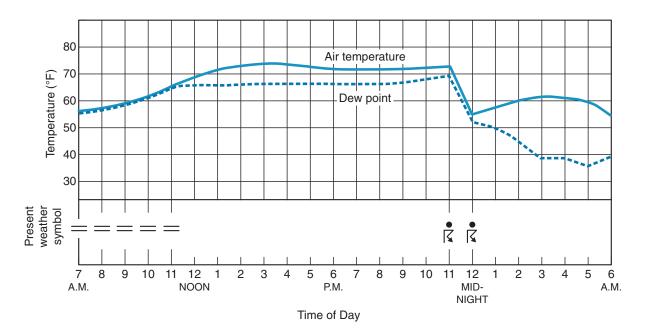
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6. Why do cold fronts usually travel faster than warm fronts?

- (1) cold air is more dense than warm air
- (2) warm air is more dense than cold air
- (3) cold fronts bring higher temperatures
- (4) warm fronts bring lower temperatures

Part B

Base your answers to questions 7 through 9 on the graph below, which shows changes in air temperature and dew point at Dallas, Texas. Symbols below the graph indicate weather conditions during the time of this graph.



- **7.** Which choice below best describes the weather event that was most likely occurring in Dallas at the time indicated?
 - (1) At 6 P.M., a warm front was passing through.
 - (2) At 11 P.M., a warm front was passing through.
 - (3) At 6 P.M., a cold front was passing through.
 - (4) At 11 P.M., a cold front was passing through.

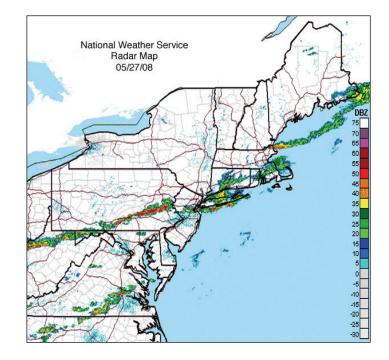
8. What were the weather conditions in the late morning hours of the first day?

- (1) thunderstorms (3) haze
- (2) fog (4) heavy rain

- 9. When was the relative humidity the highest at Dallas?
 - (1) 10 A.M. on the first day
 - (2) 12 noon on the first day
 - (3) 10 P.M. on the first day
 - (4) 4 A.M. on the second day
- **10.** The map below shows precipitation patterns on May 27, 2008. The darkest areas are experiencing the most precipitation.

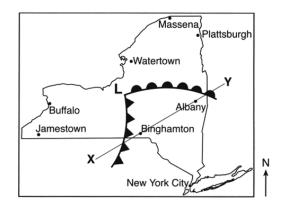
What weather event is most likely shown by this map?

- (1) a warm front moving to the southeast
- (2) a warm front moving to the northeast
- (3) a cold front moving to the southeast
- (4) a cold front moving to the northeast

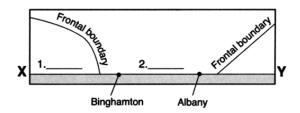


Part C

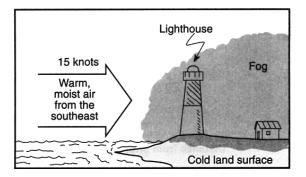
Base your answers to questions 11 and 12 on diagram below, which shows weather conditions over New York State on a specific day in July.



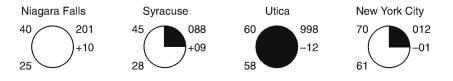
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- **11.** Make a sketch of the diagram below and on it show the proper abbreviations for the air masses at 1 and 2.



- **12.** For which city is the following weather forecast most appropriate? "In the next hour heavy rain is expected with possible lightning and thunder. Temperatures will become much cooler."
- **13.** Draw a box about 2 cm on each side to represent a regional weather map. To the right of the box, draw an arrow indicating that north is toward the top of the box. Draw a warm front moving to the northeast and indicate the positions of continental polar and maritime tropical fronts in their proper positions.
- **14.** Draw a weather station model to properly represent the weather conditions shown in the diagram of a coastal lighthouse below. Include the present weather, temperature, dew point, atmospheric pressure, and wind speed and direction. The temperature is 36°F, the relative humidity is 100%, and the air pressure is 995.1 mb. The sky above the lighthouse is overcast.

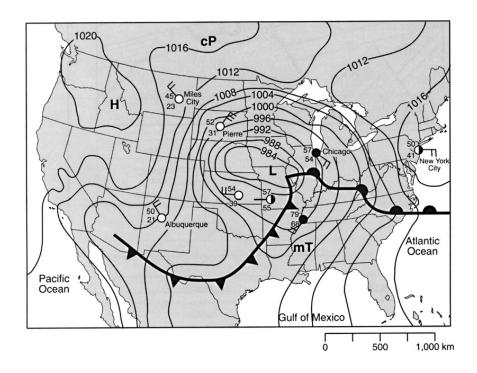


Base your answers to questions 15 through 17 on the weather station symbols below, which indicate weather conditions at the following cities in New York State: Niagara Falls, Syracuse, Utica, and New York City.



- **15.** What was the air pressure at Niagara Falls? Be sure to give the correct units of measure.
- **16.** Explain why the symbols indicate that Utica has the greatest chance of precipitation.
- **17.** Make a copy of the weather station model for New York City. Add the following information in the proper locations and format: winds from the south at 15 knots and hazy conditions with three-quarters of a mile visibility.

Base your answers to questions 18 through 20 on the weather map below. Isolines on the weather map show air pressures in millibars.



- 18. Over what geographic feature is the mT air mass likely to have originated?
- **19.** Write the names of these cities in the sequence from lowest relative humidity to the highest relative humidity: Albuquerque, Chicago, and New York City.
- **20.** What is the present Celsius temperature in New York City?