

# Weather

Chapter 25  
Modern Earth Science

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# Air Masses

Chapter 25  
Section 1  
Modern Earth Science

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## Section 25.1 Objectives

- ◆ **Explain** how an air mass forms.
- ◆ **List** the four main types of air masses.
- ◆ **Describe** how air masses affect the weather of North America.

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## 25.1 Air Masses

- ◆ Differences in air pressure are caused by unequal heating of Earth's surface.
- ◆ Equatorial regions receive more solar energy than polar regions.
- ◆ Cold air near the pole sinks and creates high-pressure centers.
- ◆ Differences in air pressure at different locations on Earth create wind patterns.
- ◆ Air moves from areas of high pressure to areas of low pressure.
- ◆ So... there is a general, worldwide movement of surface air from the poles toward the equator.

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## Air Masses

**air mass** a large body of air throughout which temperature and moisture content are similar

- ◆ Air pressure differences affect air movement.
- ◆ Air masses that form over frozen polar regions are very cold and dry. Air masses that form over tropical oceans are warm and moist.

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## Types of Air Masses

- ◆ Air masses are classified according to their source regions.
- ◆ The source regions for cold air masses are polar areas. The source regions for warm air masses are tropical areas.
- ◆ Air masses that form over the ocean are called **maritime**. Air masses that form over land are called **continental**.

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## Continental Air Masses

There are two types of continental air masses: *continental Polar* (cP) and *continental Tropical* (cT).

- ◆ continental Polar air masses are cold and dry.
- ◆ continental Tropical air masses are warm and dry.
- ◆ Air masses can stay over its source region for days or weeks. Eventually, the air mass will move into other regions because of global winds.

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## Maritime Air Masses

Maritime air masses bring precipitation and fog.

- ◆ The two different maritime air masses are *maritime Polar* (mP) and *maritime Tropical* (mT).
- ◆ maritime Polar air masses are moist and cold.
- ◆ maritime Tropical air masses are moist and warm.

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## Polar Air Masses

Maritime polar Pacific air masses form over the North Pacific Ocean and are very moist.

- ◆ In winter, these maritime polar Pacific air masses bring rain and snow to the Pacific Coast.
- ◆ In summer, they bring cool, often foggy weather.

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## Polar Air Masses, *continued*

- ◆ Maritime polar Atlantic air masses move generally eastward toward Europe. But they sometimes move westward over New England and eastern Canada.
- ◆ In winter, they can bring cold, cloudy weather and snow.
- ◆ In summer, these air masses can produce cool weather, low clouds, and fog.

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## Tropical Air Mass

- ◆ Continental tropical air masses form over the deserts of the Southwestern United States.
- ◆ These air masses bring dry, hot weather in the summer. They do not form in the winter.
- ◆ Maritime tropical air masses form over the warm water of the tropical Atlantic Oceans.
- ◆ Maritime tropical air masses also form over the warm areas of the Pacific Oceans.

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## Section 25.1 Review

1. Define *air mass*.
2. What is the name of the air mass that forms over the warm water of the Gulf of Mexico? What letters designate the source region of this air mass?
3. Suppose snow is falling on the Pacific Coast area. What type of air mass is probably responsible for this weather? What letters designate the source region of this air mass?

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## Fronts

Chapter 25  
Section 2  
Modern Earth Science

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## Section 25.2 Objectives

- ◆ **Compare** the characteristic weather patterns of cold fronts with those of warm fronts.
- ◆ **Describe** how a midlatitude cyclone forms.
- ◆ **Describe** the development of hurricanes, thunderstorms, and tornadoes.

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## Fronts

- ◆ A cool air mass is dense and does not mix with the less-dense air of a warm air mass.
- ◆ a **front** is a boundary that forms between air masses.
- ◆ Middle-latitude weather changes usually take place along the various types of fronts.
- ◆ Fronts do not exist in the Tropics because no air masses that have significant temperature differences exist there.

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## Cold & Warm Fronts

- cold front** the front edge of a moving mass of cold air that pushes beneath a warmer air mass like a wedge
- ◆ If the warm air is moist, clouds will form.
- warm front** the front edge of advancing warm air mass that replaces colder air with warmer air
- ◆ A warm front generally produces precipitation over a large area and may cause violent weather.

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## Stationary and Occluded Fronts

- ◆ **stationary front** a front of air masses that moves either very slowly or not at all
- ◆ **occluded front** a front that forms when a cold air mass overtakes a warm air mass and lifts the warm air mass off the ground and over another air mass

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## Polar Fronts

- ◆ The boundary where cold polar air meets the tropical air mass of the middle latitudes, especially over the ocean, is called the *polar front*.
- ◆ Waves commonly develop along the polar front.
- ◆ A *wave* is a bend that forms in a cold front or stationary front.

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## Wave Cyclones

**midlatitude cyclone** an area of low pressure that is characterized by rotating wind that moves toward the rising air of the central low-pressure region

- ◆ Waves are the beginnings of low-pressure storm centers called midlatitude cyclones or *wave cyclones*.
- ◆ These cyclones strongly influence weather patterns in the middle latitudes.

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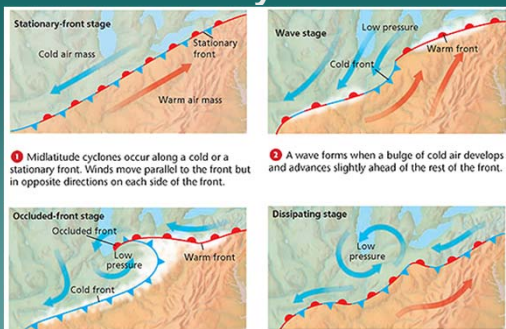
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## Wave Cyclones



- 1 Midlatitude cyclones occur along a cold or a stationary front. Winds move parallel to the front but in opposite directions on each side of the front.
- 2 A wave forms when a bulge of cold air develops and advances slightly ahead of the rest of the front.
- 3 As the fast-moving part of the cold front overtakes the warm front, an occluded front forms and the storm reaches its highest intensity.
- 4 Eventually, the system generally loses all of its energy and the midlatitude cyclone dissipates.

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## Thunderstorms

- ◆ **thunderstorm** a usually brief, heavy storm that consists of rain, strong winds, lightning, and thunder
- ◆ T-storms develop in three distinct stages.
- ◆ The t-storm dissipates as the supply of water vapor decrease.

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## Lightning

- ◆ During a t-storm, clouds discharge electricity in the form of *lightning*.
- ◆ The released electricity heats the air, and the air rapidly expands and produces a loud noise known as *thunder*.
- ◆ For lightning to occur, the clouds must have areas that carry distinct electrical charges.

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## Hurricanes

- ◆ **hurricane** a severe storm that develops over tropical oceans and whose strong winds of more than 120 km/h spiral in toward the intensely low-pressure storm center
- ◆ A hurricane begins when warm, moist air over the ocean rises rapidly.
- ◆ When moisture in the rising warm air condenses, a large amount of energy in the form of *latent heat* is released. This heat increases the force of the rising air.

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## Tornadoes

**tornado** a destructive, rotating column of air that has very high wind speeds and that maybe visible as a funnel-shaped cloud

- ◆ The smallest, most violent, and shortest-lived severe storm is a tornado.
- ◆ A tornado forms when a thunderstorm meets high-altitude horizontal winds. These winds cause the rising air in the thunderstorm to rotate.

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## Weather Instruments

Chapter 25  
Section 3  
Modern Earth Science

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## Section 25.3 Objectives

- ◆ **Identify** four instruments that measure lower-atmospheric weather conditions.
- ◆ **Describe** how scientists measure conditions in the upper atmosphere.
- ◆ **Explain** how computers help scientists understand weather.

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## Weather Instruments

- ◆ **Barometer**: measures air pressure. (chapter 23)
- ◆ **Psychrometers & hair hygrometers** : measure relative humidity. (ch 24)
- ◆ **Rain gauge**: measures precipitation. (chapter 24)

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## Measuring Air Temperature

- ◆ **Thermometer**: used to measure air temperature.
- ◆ **3 common types of thermometers**
- ◆ **Liquid**: expanding & contracting mercury or alcohol indicate rise or fall of temperature.
- ◆ **Bimetal**: made of 2 strips of metal that bend when heated.
- ◆ **Electrical**: as temp rises, electrical current increases.

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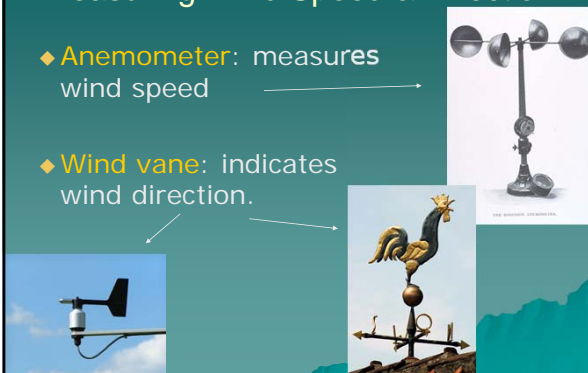
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## Measuring Wind Speed & Direction

- ◆ **Anemometer**: measures wind speed
- ◆ **Wind vane**: indicates wind direction.



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## Measuring Upper-Atmospheric Conditions

**radiosonde** a package of instruments that is carried aloft by balloons to measure upper atmospheric conditions, including temperature, dew point, and wind velocity

- ◆ The radiosonde sends measurements as radio waves to a receiver that records the information.
- ◆ When the balloon reaches a very high altitude, the balloon expands and bursts, and the radiosonde parachutes back to Earth.

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## Measuring Upper-Atmospheric Conditions, *continued*

**radar** radio detection and ranging, a system that uses reflected radio waves to determine the velocity and location of objects

- ◆ For example, large particles of water in the atmosphere reflect radar pulses.
- ◆ The newest Doppler radar can indicate the precise location, movement, and extent of a storm. It can also indicate the intensity of precipitation and wind patterns within a storm.

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## Weather Satellites

- ◆ Satellite images provide weather information for regions where observations cannot be made from ground.
- ◆ The direction and speed of the wind at the level of the clouds can also be measured by examining a continuous sequence of cloud images.
- ◆ Satellite instruments can also measure marine conditions.

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## Computers

- ◆ Before computers were available, solving the mathematical equations that describe the behavior of the atmosphere was very difficult, and sometimes impossible.
- ◆ In addition to solving many of these equations, computers can store weather data from around the world. These data can provide information that is useful in forecasting weather changes.

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## Section 25.3 Review

1. How does a bimetal thermometer work?
2. What does a radiosonde measure?
3. If a wind vane is pointing to the west, from what direction is the wind blowing? Explain your answer?

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## Forecasting the Weather

Chapter 25  
Section 4  
Modern Earth Science

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## Section 25.4 Objectives

- ◆ **Explain** how weather stations communicate weather data.
- ◆ **Explain** how a weather map is created.
- ◆ **Explain** how computer models help meteorologists forecast weather.
- ◆ **List** three types of weather that meteorologists have attempted to control.

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## Making a Weather Map

- ◆ **station model** a pattern of meteorological symbols that represent the weather at a particular observing station and that is recorded on a weather map
- ◆ Lines that connect points of equal atmospheric pressure are called **isobars**.

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## Weather Symbols

See page 513

Cloud cover (fraction of sky covered)	○ Clear	◐ $\frac{1}{8}$	◑ Scattered	◒ $\frac{3}{8}$	◓ $\frac{4}{8}$
	◔ $\frac{5}{8}$	◕ Broken	◖ $\frac{7}{8}$	● Overcast	⊗ Obscured
Wind speed (knots)	☉ Calm	1 to 2	└ 3 to 7	┘ 8 to 12	┌ 13 to 17
	└┘ 18 to 22	└┘ 23 to 27	└┘ 48 to 52	└┘ 73 to 77	└┘ 103 to 107
Wind direction	○ North	○ Northeast	○ East	○ Southeast	
	○ South	○ Southwest	○ West	○ Northwest	
Weather conditions	☂ Drizzle	≡ Fog	△ Hail	∞ Haze	● Rain
	☃ Freezing rain	☁ Smoke	✳ Snow	⚡ Thunderstorm	🌀 Hurricane
				🌀 Tropical storm	

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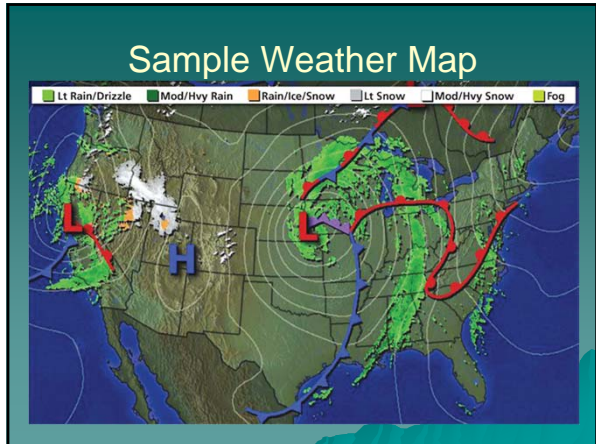
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### Types of Forecasts

Meteorologists make four types of forecasts.

- ◆ *Daily forecasts* predict for 48-hours.
- ◆ *Extended forecasts* look ahead 3 to 7 days.
- ◆ *Medium range forecasts* look ahead 8 to 14 days.
- ◆ *Long-range forecasts* cover monthly and seasonal periods.

◆ Accurate weather forecasts can be made for 0 to 7 days. However, accuracy decreases with each day.

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### Daily & Long-Term Forecasts

- ◆ To forecast the weather, meteorologists regularly plot to the intensity and path of weather systems on maps.
- ◆ Meteorologists then study the most recent weather map and compare it with maps from previous hours.
- ◆ By following the progress of weather systems, meteorologist can forecast the weather.

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## Controlling the Weather

- ◆ Some meteorologists are investigating methods of controlling rain, hail, and lightning.
- ◆ Currently, the most researched method for producing rain has been *cloud seeding*.
- ◆ Cloud seeding can also be used to prevent more severe precipitation.

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## Hurricane Control

- ◆ Hurricanes have also been seeded with *freezing nuclei* in an effort to reduce the intensity of the storm.
- ◆ During Project Stormfury, which took place from 1962 to 1983, four hurricanes were seeded, and the project had mixed results.
- ◆ Scientists have, for the most part, abandoned storm and hurricane control because it is not an attainable goal with existing technology.

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## Lightning Control

- ◆ Seeding of potential lightning storms with silver-iodide nuclei has seemed to modify the occurrence of lightning.
- ◆ However, no conclusive results have been obtained.



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## Section 25.4 Review

1. What is a station model?
2. Why are new and 24-hour old weather maps compared?
3. Explain which region on a weather map—one with widely spaced isobars or one with closely spaced isobars—has stronger winds.

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