

section 1 Earth's Atmosphere

What You'll Learn

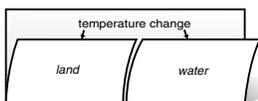
- what the atmosphere is composed of
- how the atmosphere is heated
- about Earth's water cycle

Study Coach

Highlight As you read, highlight key ideas and words in each paragraph.

FOLDABLES™

A Summarize Make a two-tab Foldable like the one shown to summarize how Earth's varied surface heats the atmosphere.



Before You Read

When you are outside and you want to check the weather, you probably look up at the sky. What are you looking for? What clues does Earth's atmosphere give about the weather?

Read to Learn

Atmospheric Composition

You probably never think about the air you breathe. Your body uses only the oxygen in the air. But, oxygen is only one part of air. Earth's atmosphere is a mixture of gases. It consists of about 78 percent nitrogen, 21 percent oxygen, and smaller amounts of argon and water vapor. Trace gases make up a very small part of the atmosphere. Trace gases include carbon dioxide, water vapor, methane, nitrous oxide, and ozone.

What do biological processes affect?

Respiration in the cells of organisms produces trace gases, such as water vapor and carbon dioxide. These gases are released into the air. During photosynthesis, certain organisms take carbon dioxide out of the air and release oxygen into it. Organisms produce nearly all of the atmospheric oxygen.

Microorganisms in swamps and soil release nitrogen and methane. Microorganisms in the digestive tracts of animals, such as termites and cows, also release methane.

How did Earth's atmosphere form?

Earth's early atmosphere contained mostly hydrogen and helium. These gases were lost and were replaced by volcanic gases, such as carbon dioxide and water vapor. Photosynthetic organisms in the oceans released oxygen into the atmosphere. Over time, the oxygen built up.

Ozone Layer Intense radiation from the Sun changed some of the oxygen into ozone. The ozone accumulated in the upper atmosphere. The ozone layer protected Earth from some of the Sun's harmful ultraviolet rays. This allowed photosynthetic organisms to grow on land, so more oxygen was released into the atmosphere.

It took many millions of years for Earth's atmosphere to reach its current state. There is a delicate balance between processes that produce gases and processes that destroy them. However, humans might be upsetting this balance.

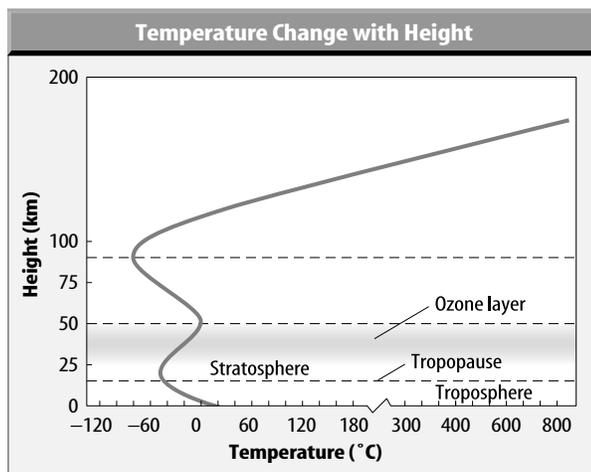
Atmospheric Structure

Earth's atmosphere extends more than 1,000 km above Earth's surface, as shown in the figure below. Most of the atmosphere lies within 15 km of the surface in a region called the troposphere. The **troposphere** is the layer of the atmosphere in which most weather takes place. In the troposphere, the temperatures normally decrease with height. ✓

Sometimes, the temperature increases with height. A **temperature inversion** is an event that occurs near the ground when air temperature increases with height. When this happens, the air is very stable. The air resists the rising motion that is needed to form clouds or to scatter pollution.

What is the stratosphere?

The stratosphere is the layer above the troposphere. It is extremely dry and rich in ozone. In this layer, the temperature increases with height. This creates a permanent inversion. The inversion begins at a place called the tropopause. It acts like a lid that keeps the troposphere from rising into the stratosphere. The upper layers of the atmosphere are so thin that they do not take part in weather production.



✓ Reading Check

1. **Explain** In which layer of the atmosphere does most weather take place?

Picture This

2. **Identify** Use one color of highlighter to mark the part of the atmosphere where most weather occurs. Use another color to mark the part that is very dry and rich in ozone.

Heating the Atmosphere

The Sun's energy heats Earth's atmosphere. High above Earth in the stratosphere, solar radiation is intense. The solar radiation splits oxygen molecules into single atoms. These oxygen atoms then recombine to form ozone. Ozone absorbs nearly all the Sun's ultraviolet (UV) rays. This absorption by ozone is why temperature increases with height in the stratosphere.

The rest of the solar rays pass through the atmosphere to Earth's surface. Earth absorbs some solar radiation and reflects some to the atmosphere. The heated surface of Earth gives off long-wave infrared radiation. Long wavelengths are absorbed by trace gases, especially carbon dioxide and water vapor. The **greenhouse effect** is the absorbing of long-wavelength radiation by trace gases and the re-emitting of infrared radiation back to Earth's surface. The greenhouse effect keeps Earth warm by absorbing heat and trapping it near the surface. ✓

✓ Reading Check

3. **Identify** What is the greenhouse effect?

What causes heating?

The atmosphere's most abundant gases are nitrogen and oxygen. They absorb little radiation and so do not add much heat to the atmosphere. On the other hand, water vapor and carbon dioxide are strong absorbers of radiation. Although they make up very little of the atmosphere, they heat the atmosphere the most.

Earth's surface also heats the atmosphere through conduction, convection, and latent heat. **Latent heat** is the energy released or absorbed during the phase changes of water, such as evaporating water or melting snow. Latent heat energy is released into the atmosphere when water vapor condenses as clouds.

A Varied Surface

Because Earth's surface is extremely varied, it heats the atmosphere unevenly. Snow, ice, water, plant cover, and bare soil reflect different amounts of solar radiation into space. They heat at different rates when they absorb solar radiation. For example, dry land absorbs energy rapidly and emits much radiation to the atmosphere. In contrast, water heats slowly and holds energy longer. This uneven surface heating causes atmospheric pressure differences and wind.

Smooth surfaces of rock or water can be reflective of many energy types. Color is also a factor in determining energy absorption or reflection.

Think it Over

4. **Determine** What surface materials reflect the most solar radiation out into space?

Water in the Atmosphere

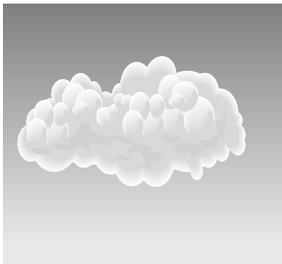
Uneven heating has another effect. It creates air currents that carry water vapor aloft and form clouds. Air generally rises over warm surfaces and sinks over cold surfaces. Many birds and hang gliders soar on these warm, rising air currents called thermals.

Heated air expands and rises. To form clouds, moist air must rise high enough to be cooled to its dew point. At this temperature, air becomes saturated and water vapor condenses to form cloud droplets. Small particles in the air, called particulates, trigger this process. Sometimes there are a lot of these particulates in the air, such as dust or air pollution. When there are lot of particulates present, they can cause condensation even when the air is not saturated. This is how smog forms.

What clouds cause precipitation?

The formation of clouds is the first step in the process of precipitation. Precipitation is the term for moisture that falls from clouds as rain, hail, or snow. Different types of clouds are shown in the figure below. Two main types of clouds bring precipitation. These are the puffy cumulus type and the flat, long stratus type.

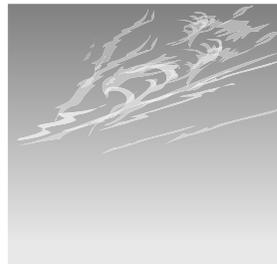
Cumulus clouds form from rising air parcels and indicate fair weather, but may produce brief rain showers. Stratus clouds form mainly when layers of air rise gently. Stratus clouds produce drizzle or a long, steady rain. Cirrus clouds are mostly ice crystals because they form at high altitudes. Many in-between types of clouds may form depending on how stable the air is and how high the clouds are in the atmosphere.



Cumulus



Stratus



Cirrus

Thunder Clouds You have probably seen many types of clouds, including the cumulonimbus, or thunder clouds. Cumulonimbus clouds form in unstable air and usually bring heavy rain or thunderstorms.



Think it Over

5. **Explain** Smog can form when the air over a city is polluted. What are some types of air pollution that might cause smog to form?

Picture This

6. **Circle** the cloud type that forms highest in the atmosphere. What is it called?

✓ Reading Check

7. **Explain** How do water droplets in clouds become large enough to fall as rain?

Picture This

8. **Circle** the part of the water cycle in which water is returned to Earth's surface.

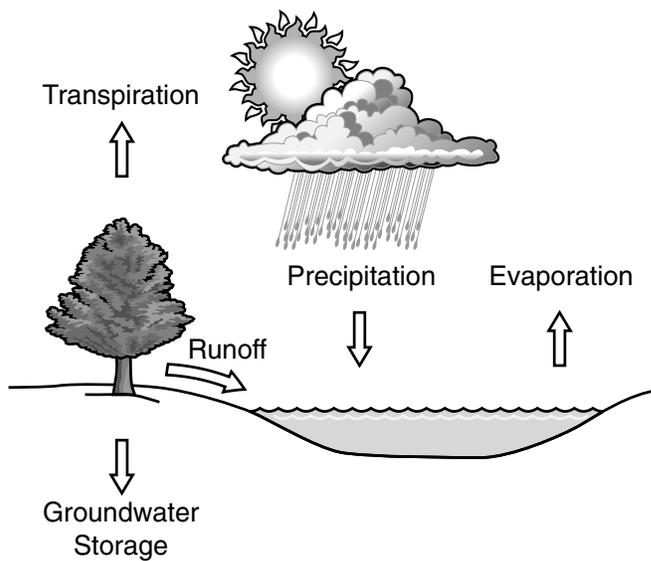
How do raindrops form?

Water droplets in clouds are usually so small that they are kept in the air by air currents. At times, they evaporate before they reach Earth. For precipitation to occur, the droplets must grow large. Droplets that grow when they collide and combine are called warm rain. Faster growth occurs when water droplets combine with ice crystals high in the atmosphere. This process is called cold rain. ✓

Global Water Cycle

The global water cycle, shown below, includes the processes of precipitation, runoff of water from the land, storage of groundwater, and evaporation. Plants play an important part in the water cycle. They affect how much water the soil absorbs and how much water runs off the land. Plants also return water to the air. They do this through the processes of transpiration—a kind of evaporation from their leaves.

People affect the water cycle in many ways. Humans pump groundwater for drinking or irrigation. They cut down forests and plant fields of crops. They drain swamps, pave land, build cities, and turn deserts into golf courses. Many of these activities have reduced water quality and water resources. Careful planning is needed to preserve Earth's water resources.



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● After You Read

Mini Glossary

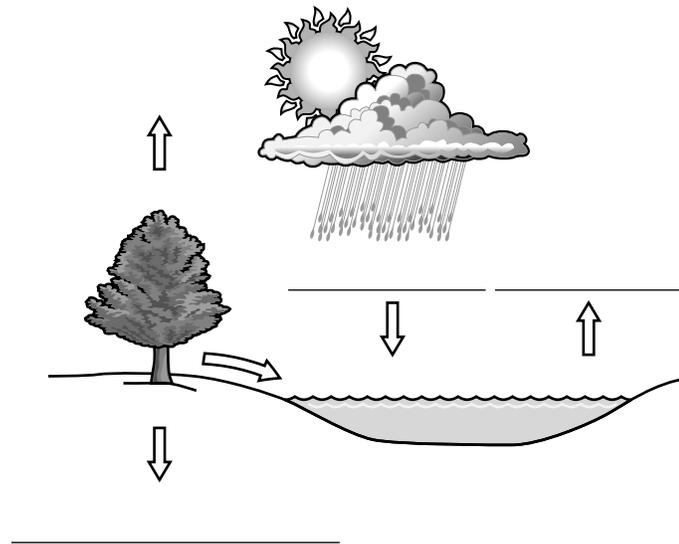
greenhouse effect: the absorbing of long-wavelength radiation by trace gases and re-emitting of infrared radiation back to Earth's surface

temperature inversion: an event that occurs near the ground when temperatures increase with height

troposphere: the layer of the atmosphere where most of the weather takes place

1. Review the vocabulary terms and their definitions in the Mini Glossary. Use at least one term to write a sentence describing how heat is kept near Earth's surface.

2. Label the water cycle diagram below.



3. **Study Coach** You highlighted key ideas and terms as you read this section. How did this help you understand the information you read?

