

Encyclopedic Entry

water cycle

hydrologic cycle

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The water cycle describes how water is exchanged (cycled) through Earth's land, ocean, and atmosphere. Water always exists in all three places, and in many forms—as lakes and rivers, glaciers and ice sheets, oceans and seas, underground aquifers, and vapor in the air and clouds.

Evaporation, Condensation, and Precipitation

The water cycle consists of three major processes: evaporation, condensation, and precipitation.

Evaporation

Evaporation is the process of a liquid's surface changing to a gas. In the water cycle, liquid water (in the ocean, lakes, or rivers) evaporates and becomes water vapor.

Water vapor surrounds us, as an important part of the air we breathe. Water vapor is also an important greenhouse gas. Greenhouse gases such as water vapor and carbon dioxide insulate the Earth and keep the planet warm enough to maintain life as we know it.

The water cycle's evaporation process is driven by the sun. As the sun interacts with liquid water on the surface of the ocean, the water becomes an invisible gas (water vapor). Evaporation is also influenced by wind, temperature, and the density of the body of water.

Condensation

Condensation is the process of a gas changing to a liquid. In the water cycle, water vapor in the atmosphere condenses and becomes liquid.

Condensation can happen high in the atmosphere or at ground level. Clouds form as water vapor condenses, or becomes more concentrated (dense). Water vapor condenses around tiny particles called cloud condensation nuclei (CCN). CCN can be specks of dust, salt, or pollutants. Clouds at ground level are called fog or mist.

Like evaporation, condensation is also influenced by the sun. As water vapor cools, it reaches its saturation limit, or dew point. Air pressure is also an important influence on the dew point of an area.

Precipitation

Unlike evaporation and condensation, precipitation is not a process. Precipitation describes any liquid or solid water that falls to Earth as a result of condensation in the atmosphere. Precipitation includes rain, snow, and hail.

Fog is not precipitation. The water in fog does not actually precipitate, or liquify and fall to Earth. Fog and mist are a part of the water cycle called suspensions: They are liquid water suspended in the atmosphere.

Precipitation is one of many ways water is cycled from the atmosphere to the Earth or ocean.

Other Processes

Evaporation, condensation, and precipitation are important parts of the water cycle. However, they are not the only ones.

Runoff, for instance, describes a variety of ways liquid water moves across land. Snowmelt, for example, is an important type of runoff produced as snow or glaciers melt and form streams or pools.

Transpiration is another important part of the water cycle. Transpiration is the process of water vapor being released from plants and soil. Plants release water vapor through microscopic pores called stomata. The opening of stomata is strongly influenced by light, and so is often associated with the sun and the process of evaporation. Evapotranspiration is the combined components of evaporation and transpiration, and is sometimes used to evaluate the movement of water in the atmosphere.

States of Water

Through the water cycle, water continually circulates through three states: solid, liquid, and vapor.

Ice is solid water. Most of Earth's freshwater is ice, locked in massive glaciers, ice sheets, and ice caps.

As ice melts, it turns to liquid. The ocean, lakes, rivers, and underground aquifers all hold liquid water.

Water vapor is an invisible gas. Water vapor is not evenly distributed across the atmosphere. Above the ocean, water vapor is much more abundant, making up as much as 4% of the air. Above isolated deserts, it can be less than 1%.

The Water Cycle and Climate

The water cycle has a dramatic influence on Earth's climate and ecosystems.

Climate is all the weather conditions of an area, evaluated over a period of time. Two weather conditions that contribute to climate include humidity and temperature. These weather conditions are influenced by the water cycle.

Humidity is simply the amount of water vapor in the air. As water vapor is not evenly distributed by the water cycle, some regions experience higher humidity than others. This contributes to radically different climates. Islands or coastal regions, where water vapor makes up more of the atmosphere, are usually much more humid than inland regions, where water vapor is scarcer.

A region's temperature also relies on the water cycle. Through the water cycle, heat is exchanged and temperatures fluctuate. As water evaporates, for example, it absorbs energy and cools the local environment. As water condenses, it releases energy and warms the local environment.

The Water Cycle and the Landscape

The water cycle also influences the physical geography of the Earth. Glacial melt and erosion caused by water are two of the ways the water cycle helps create Earth's physical features.

As glaciers slowly expand across a landscape, they can carve away entire valleys, create mountain peaks, and leave behind rubble as big as boulders. Yosemite Valley, part of Yosemite National Park in the U.S. state of California, is a glacial valley. The famous Matterhorn, a peak on the Alps between Switzerland and Italy, was carved as glaciers collided and squeezed up the earth between them. Canada's "Big Rock" is one of the world's largest "glacial erratics," boulders left behind as a glacier advances or retreats.

Glacial melt can also create landforms. The Great Lakes, for example, are part of the landscape of the Midwest of the United States and Canada. The Great Lakes were created as an enormous ice sheet melted and retreated, leaving liquid pools.

The process of erosion and the movement of runoff also create varied landscapes across the Earth's surface. Erosion is the process by which earth is worn away by liquid water, wind, or ice.

Erosion can include the movement of runoff. The flow of water can help carve enormous canyons, for example. These canyons can be carved by rivers on high plateaus (such as the Grand Canyon, on the Colorado Plateau in the U.S. state of Arizona). They can also be carved by currents deep in the ocean (such as the Monterey Canyon, in the Pacific Ocean off the coast of the U.S. state of California).

Reservoirs and Residence Time

Reservoirs are simply where water exists at any point in the water cycle. An underground aquifer can store liquid water, for example. The ocean is a reservoir. Ice sheets are reservoirs. The atmosphere itself is a reservoir of water vapor.

Residence time is the amount of time a water molecule spends in one reservoir. For instance, the residence time of "fossil water," ancient groundwater reservoirs, can be thousands of years. Some fossil water reservoirs beneath the Sahara Desert have existed for 75,000 years.

Residence time for water in the Antarctic ice sheet is about 20,000 years. That means that a molecule of water will stay as ice for about that amount of time.

The residence time for water in the ocean is much shorter-about 3,200 years.

The residence time of water in the atmosphere is the shortest of all-about nine days.

Calculating residence time can be an important tool for developers and engineers. Engineers may consult a reservoir's residence time when evaluating how quickly a pollutant will spread through the reservoir, for instance. Residence time may also influence how communities use an aquifer.

VOCABULARY

Term	Part of Speech	Definition
air pressure	noun	force pressed on an object by air or atmosphere.
aquifer	noun	an underground layer of rock or earth which holds groundwater.
atmosphere (atm)	noun	(atm) unit of measurement equal to air pressure at sea level, about 14.7 pounds per square inch. Also called standard atmospheric pressure.
canyon	noun	deep, narrow valley with steep sides.
climate	noun	all weather conditions for a given location over a period of time.
cloud	noun	visible mass of tiny water droplets or ice crystals in Earth's atmosphere.
cloud condensation nuclei (CCN)	plural noun	microscopic bits of clay, salt, or solid pollutant around which water vapor condenses in clouds to form raindrops.
condensation	noun	process by which water vapor becomes liquid.
current	noun	steady, predictable flow of fluid within a larger body of that fluid.
density	noun	number of things of one kind in a given area.
dew point	noun	temperature at which water in the air condenses to form water droplets on objects near the ground.
diffuse	verb	to spread out or scatter.
ecosystem	noun	community and interactions of living and nonliving things in an area.

erosion	noun	act in which earth is worn away, often by water, wind, or ice.
evaporation	noun	process by which liquid water becomes water vapor.
evapotranspiration	noun	loss of water from the Earth's soil by evaporation into the atmosphere and transpiration by plants.
fluctuate	verb	to constantly change back and forth.
fog	noun	clouds at ground level.
freshwater	adjective	having to do with a habitat or ecosystem of a lake, river, or spring.
glacial erratic	noun	rock, deposited by a glacier, that differs from the geology and landscape in which it is found.
glacial valley	noun	depression in the earth created by a moving glacier.
glacier	noun	mass of ice that moves slowly over land.
Great Lakes	noun	largest freshwater bodies in the world, located in the United States and Canada. Lake Huron, Lake Ontario, Lake Michigan, Lake Erie, and Lake Superior make up the Great Lakes.
greenhouse gas	noun	gas in the atmosphere, such as carbon dioxide, methane, water vapor, and ozone, that absorbs solar heat reflected by the surface of the Earth, warming the atmosphere.
groundwater	noun	water found in an aquifer.
humidity	noun	amount of water vapor in the air.
ice	noun	water in its solid form.
ice cap	noun	area of fewer than 50,000 square kilometers (19,000 square miles) covered by ice.
ice sheet	noun	thick layer of glacial ice that covers a large area of land.
insulate	verb	to cover with material to prevent the escape of energy (such as heat) or sound.
lake	noun	body of water surrounded by land.
landform	noun	specific natural feature on the Earth's surface.
landscape	noun	the geographic features of a region.
microscopic	adjective	very small.
Midwest	noun	area of the United States consisting of the following states: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.
physical geography	noun	study of the natural features and processes of the Earth.
plateau	noun	large region that is higher than the surrounding area and relatively flat.
pollutant	noun	chemical or other substance that harms a natural resource.
pore	noun	tiny opening.
precipitation	noun	all forms in which water falls to Earth from the atmosphere.
residence time	noun	amount of time a water molecule spends in one place in the water cycle.

river	noun	large stream of flowing fresh water.
runoff	noun	overflow of fluid from a farm or industrial factory.
snowmelt	noun	water supplied by snow.
stomata	plural noun	(singular: stoma) tiny openings on the surface of leaves that control the exchange of gases in a plant.
temperature	noun	degree of hotness or coldness measured by a thermometer with a numerical scale.
transpiration	noun	evaporation of water from plants.
valley	noun	depression in the Earth between hills.
vapor	noun	visible liquid suspended in the air, such as fog.
water cycle	noun	movement of water between atmosphere, land, and ocean.
weather	noun	state of the atmosphere, including temperature, atmospheric pressure, wind, humidity, precipitation, and cloudiness.
wind	noun	movement of air (from a high pressure zone to a low pressure zone) caused by the uneven heating of the Earth by the sun.

For Further Exploration

Articles & Profiles

• National Geographic News: Saturn's Moon Has Water Cycle Like Earth's

Websites

• USGS: Water Science for Schools—The Water Cycle



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