Waterworks!

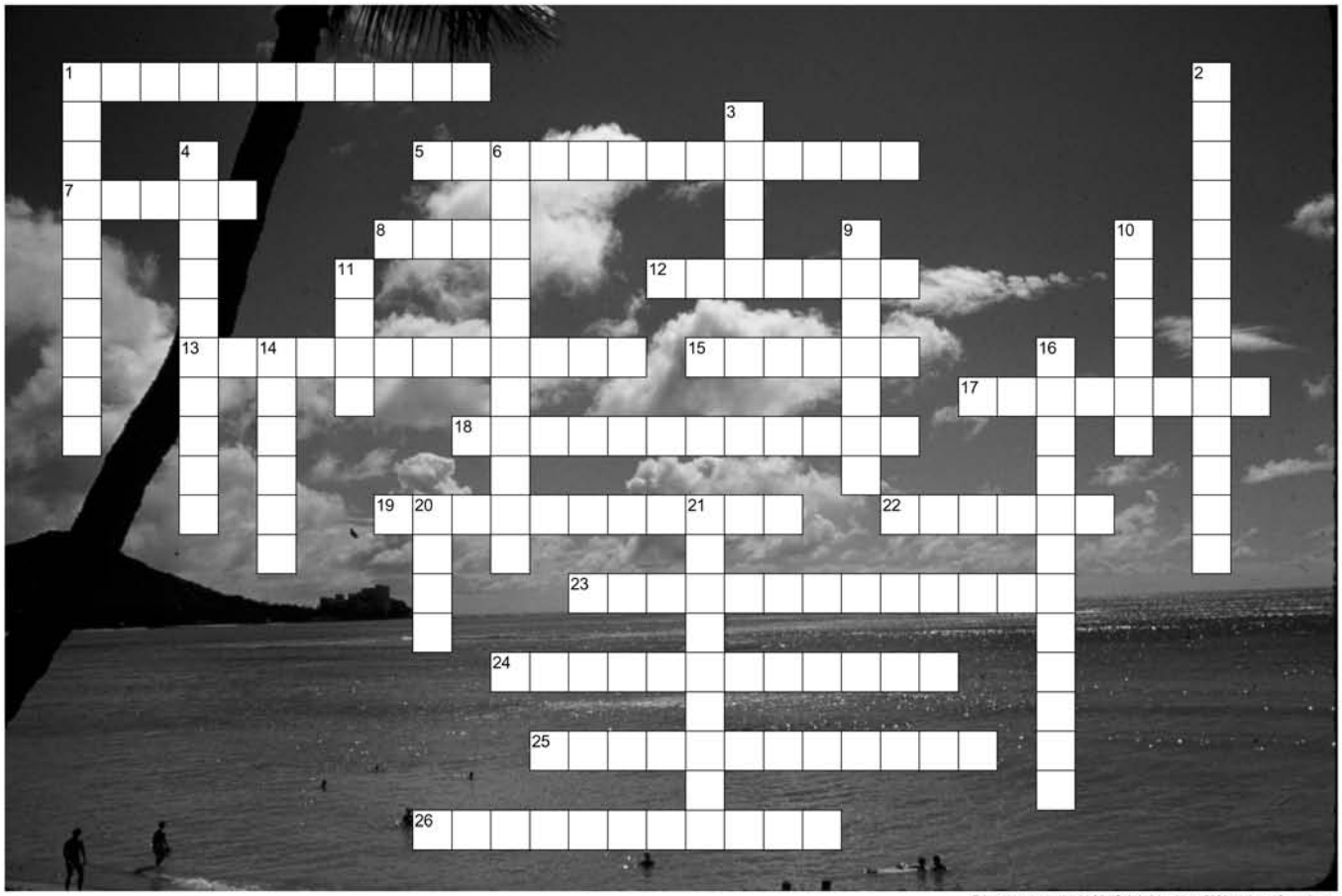

Photo courtesy of NOAA National Weather Service

Across

1 Thin, wide stretches of gray in the middle altitudes.
5 Like sweating, for plants.
7 A drink of this leaves you thirstier.
8 _____ and pepper.
12 Low-level layers covering the sky.
13 High in the sky and ripply.
15 High and wispy with no sense of humor
17 Studies clouds from top to bottom.
18 The mighty cloud king.
19 The stuff of wells.
22 When it comes to water, Earth's on a fixed _____.
23 Low-sky rolling masses.
24 High in the sky and stretched thin.
25 Low-level givers of rain.
26 Oh, dry up.

Down

1 Airy wrapping around our planet.
2 What went up comes down.
3 Invisible water.
4 Lifts a dew drop to a cloud and returns it as a snowflake.
6 Puffy patches in the middle of the sky.
9 Low-sky fluffy cotton balls.
10 Hydrological moving vans.
11 Without which a sled is useless.
14 The stuff of rivers and streams.
16 Was gas, now liquid.
20 Falls mainly in the plain in Spain.
21 Let's get this water moving!

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Water Works on the Blue Planet

Water, water, every where,
And all the boards did shrink;
Water, water, every where,
Nor any drop to drink.

. . .

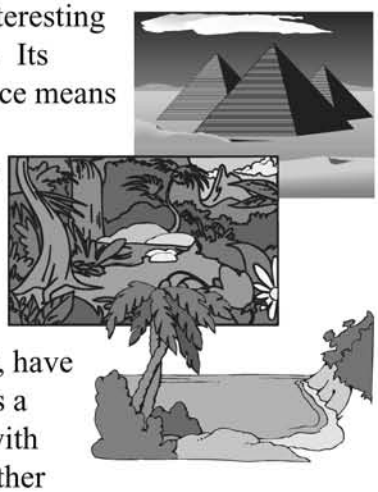
And every tongue, through utter drought,
Was withered at the root;
We could not speak, no more than if
We had been choked with soot.

From *The Rime of the Ancient Mariner, Part II*
By Samuel Taylor Coleridge

In Coleridge's poem, the Ancient Mariner is adrift on a windless sea, surrounded by water too salty to drink.

When we consider that almost three-fourths of Earth's surface is water, it's hard to imagine there could ever be a shortage. But of all that water, 97.5% of it is ocean water, which is too salty to drink. As for the rest, we land creatures need to take very good care of it.

Haves and Have-nots



That's the interesting thing about water. Its presence or absence means life or no life. Some places, like the Brazilian rain forest, have a lot of water, while other places, like the Sahara Desert, have none. Some years a place is flooded with rain and snow. Other years that same place is dry as a bone.

But one thing about water is always the same. There is only a certain amount of water on Earth—no more, no less—and that total doesn't change.

What changes is how it is distributed. The process by which water moves around the planet is called the water cycle, or—to be technically fancy—the hydrologic cycle.

Living on a Fixed Budget

How the water is divided up among the oceans, the land, and the atmosphere is called the water budget. Budgets are usually about money. If you have a paying job or receive an allowance, you know how much money you will receive each week or month. You must plan how you will divide this money up to buy the things you need. This process is called budgeting your money.

Earth's water budget, however, is really more like a Monopoly™ game than one person's budget. In real life, you might be able to work more to make more money. Or you might choose to stash your money under your mattress, taking it out of circulation altogether.

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In Monopoly, however, the total amount of money available for all the players remains the same. You can't just go printing more Monopoly money when you run short! The game is all about how that fixed amount of money gets spread around. Does one player get rich, leaving the other players poor? Or does the money get distributed more evenly?

In the water cycle "game," wealth (that is, water) gets redistributed by several means. But the difference between this game and Monopoly is that no matter what happens during any particular turn in the water cycle game, the "players" all end up with very close to the same amount of wealth they had at the beginning. Who are these players?

The players are the oceans, the land, and the air.

In the water cycle game, fair or not, the oceans have and keep almost all the wealth. The total of all the fresh (that is, not salty) water on land, including lakes, rivers, streams, ponds, puddles, bathtubs, kitchen sinks, and all the water under the ground, comes to only 2.4% of Earth's water. The atmosphere contains the rest, only .001% (that's 1/ 100,000th), in the form of water vapor and clouds.

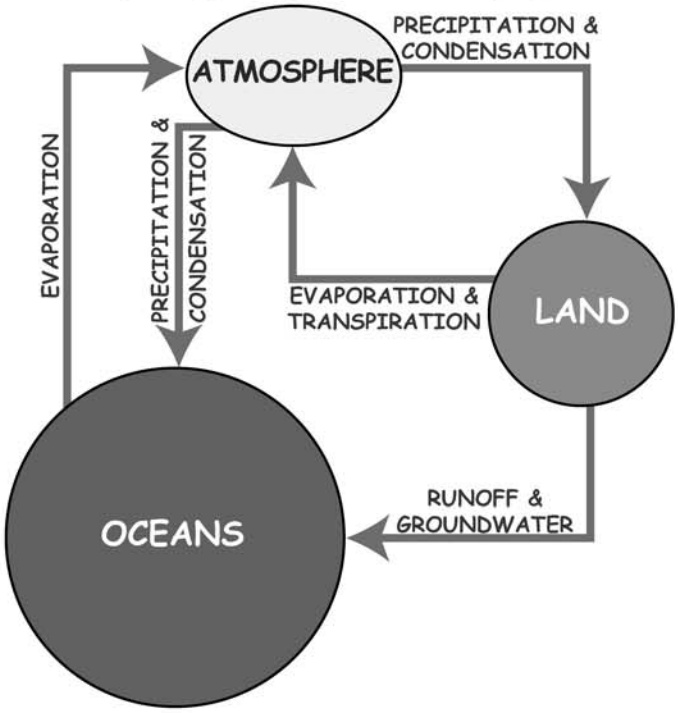
This tiny percentage of the water that is in the atmosphere at any given time is what keeps the whole system moving. The atmosphere is the transportation system that enables the water to, well, cycle. Just to give you an idea how hard the atmosphere works to move water around, imagine the entire sky, horizon to horizon, top to bottom, over the whole world being filled with dark, gray clouds. This is how much water the atmosphere can hold. Each year, the total amount of water that gets dumped out of the sky (in the form of rain, hail, snow, sleet, etc.) is 30 times more than the atmosphere's total capacity to hold water at any one time!

Water's Ups and Downs

Water gets from Earth's surface into the atmosphere in three different ways: *evaporation, sublimation*, and *transpiration*.

Water gets back from the atmosphere to Earth's surface by *precipitation* and *condensation*.

Water gets from the land back to the oceans by *runoff* and *groundwater seepage*.



Evaporation is the process of water turning from a liquid to a gas. After a rain, any little dip in the ground becomes a puddle. When the sun comes out, the puddle disappears. Where does the water go? It becomes water vapor (which is an invisible gas) and rises into the atmosphere. Water is evaporating off the surface of the oceans all the time. (Luckily for us, the salt is left behind!) Lakes, rivers, swimming pools—you name it—all contribute to the total amount of water vapor in the atmosphere. *Sublimation* is the process of water turning from a solid (snow or ice) directly to a gas (water vapor) without melting first.

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What Clouds Are These?

What kind of clouds does each picture show? Write the answers in the blanks below. Some of them may be especially hard to identify because you may not be able to judge the altitude of the clouds. Hint: Try using the process of elimination. For more help identifying clouds, visit http://cloudsat.atmos.colostate.edu and click on the link for Outreach.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

Answers:

1. Cumulus; 2. Nimbostratus; 3. Cirrus; 4. Stratocumulus; 5. Cumulonimbus; 6. Cirrocumulus; 7. Altostratus; 8. Stratus; 9. Altocumulus; 10. Cirrostratus

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Transpiration is the process of plants giving off water and oxygen as waste products of photosynthesis. As far as the water is concerned, this process is similar to evaporation, but simply refers to the water coming from the ground up through the plants, rather than coming from the ground directly.

In any event, once the water vapor gets into the air, it rises and cools, *condensing* into water droplets again. Collections of these water droplets are called clouds. Clouds get pushed great distances by atmospheric winds, and thus become the long-distance trucking industry of the water cycle. This part of the water cycle is called *transport*. Water vapor can also condense out of the atmosphere as dew or frost.

So far, the atmosphere has lifted water into the sky from one place and carried it to another place. Now it sets the water down again in the form of dew, frost, rain, snow, hail, or sleet.

When the water hits land, some of it soaks in and some runs off into lakes, streams, or rivers. The water that soaks in is called groundwater. Groundwater and runoff water all eventually get back to the ocean.

All these processes—evaporation, sublimation, transpiration, condensation, transport, precipitation, runoff, and groundwater seepage—are going on all the time all over the Earth. And still, the total amount of water on our precious blue planet remains the same.

You can see a movie of the water cycle at http://watercycle.gsfc.nasa.gov/.

Now for an Illustration

(and an activity for you)

Make a poster (perhaps working in pairs) **or a large mural** (working with the whole class) depicting the water cycle on planet Earth. You can include all different kinds of terrain—forests, deserts, farmlands, mountains, plains, rolling hills, cities—and all different kinds of clouds, rivers, lakes, streams, calm oceans, angry oceans, glaciers, cross-section views of the underground, rain, blizzards, thunderstorms, hurricanes—whatever seems interesting and dramatic and shows all the different ways water moves up into the air and back down again to the surface. Label the water elements of the picture to show which of the processes of the water cycle are being shown.

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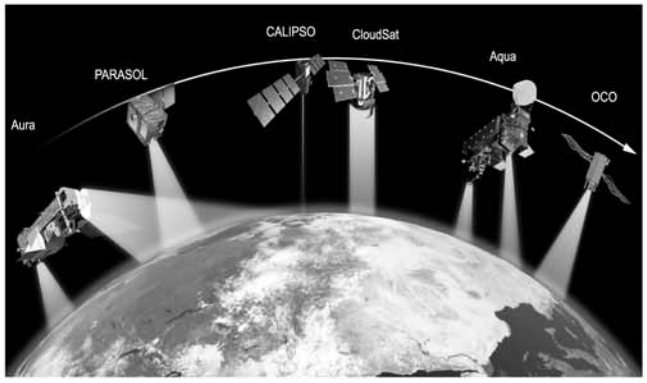


If you like, you can cut the clouds out of separate pieces of paper to make a water transport system that can really move. You can show how the clouds "pick up" water from one part of the picture and carry it to another.

Of course what drives evaporation and precipitation are the basic laws of physics. But things could be different and still obey the laws of physics. For example, what do you think would happen if all the continents were well above sea level, but perfectly flat? What if it were warm enough on Earth that all the water was in liquid form (no ice)? Given that the atmosphere cannot hold any more water than it already does, what if precipitation fell equally on all parts of Earth?

Learning More About Clouds

Clouds are the key element of the water cycle, since they are the transporters that move water from one place on Earth to another. They are also important in determining how much of the sun's energy is absorbed and trapped in the atmosphere. Thus, they are very important in altering the temperature of the air and Earth's surface. The warmer the air, the harder it is for water to condense and fall out. And the warmer the oceans, the faster water evaporates from them. And the more water in the air, the more the Sun's energy is trapped, making things still warmer.

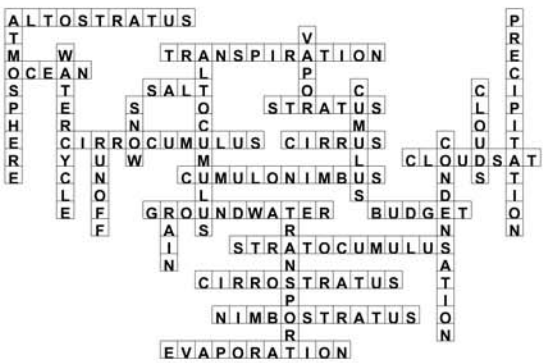
It is a very complex cycle, and scientists need to understand better how clouds affect climate. Current weather satellites give scientists information about how clouds look from the top, and even how high they are. But they don't reveal enough about the vertical structure of the clouds to really understand them.

CloudSat is a space mission that will study clouds, taking 3-D images of them using advanced radar technology. CloudSat will orbit Earth, flying in formation with another satellite, called CALIPSO, as well as three additional satellites that take cloud measurements using different kinds of instruments. CloudSat will measure how much liquid water and ice are in the clouds at what heights, and how these factors affect the clouds' ability to reflect or trap the sun's energy. Data collected by all five satellites will be combined, along with measurements of temperature and precipitation on the ground, to give us a better understanding than ever before of how clouds work and how they affect climate all over Earth.

CloudSat launches in 2004. It is a joint project between Colorado State University, NASA's Jet Propulsion Laboratory, the Canadian Space Agency, the U.S. Air Force, and the U.S. Department of Energy. To learn more about CloudSat, see http://cloudsat.atmos.colostate.edu/.

Please take a moment to evaluate this product at http://ehb2.gsfc.nasa.gov/edcats/educational_wallsheet. Your evaluation and suggestions are vital to continually improving NASA educational materials. Thank you.

Waterworks Crossword Solution



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