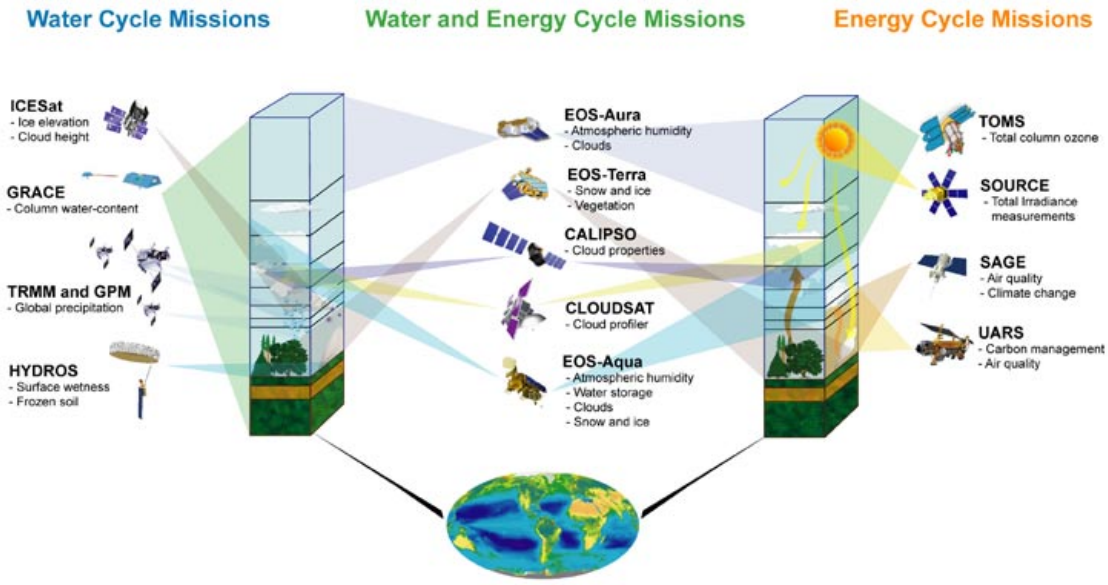
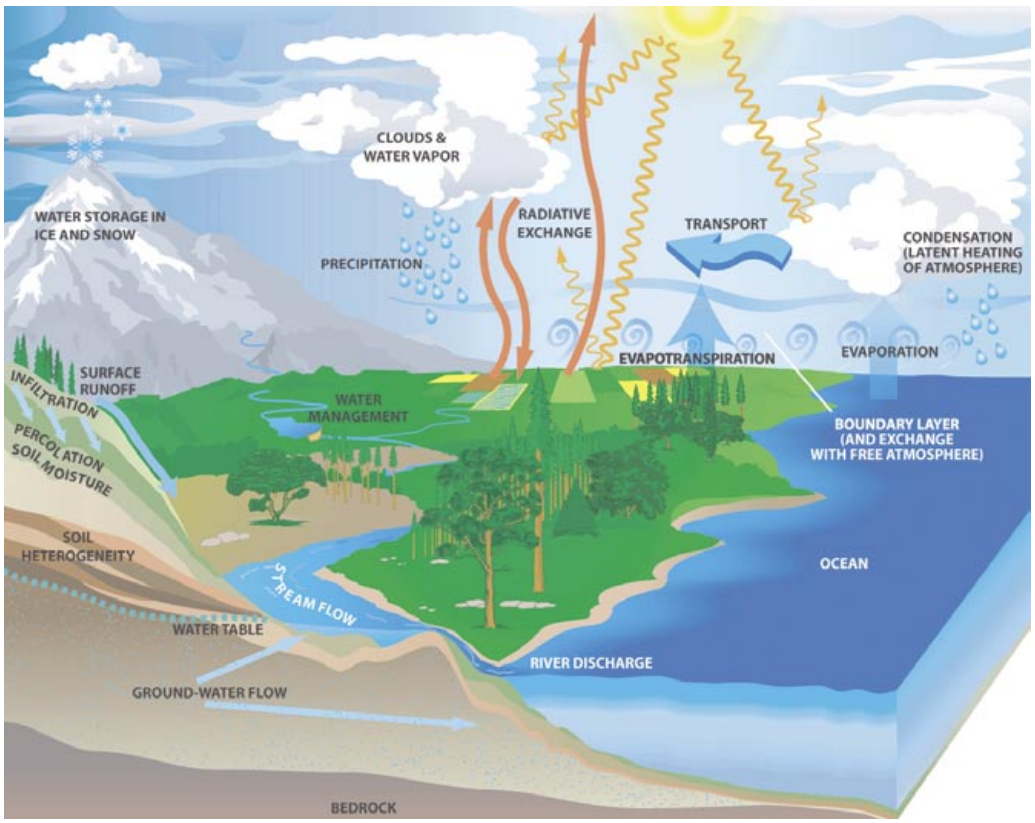
National Aeronautics and
Space Administration

Goddard Space Flight Center

The Water Cycle



Complementary Water and Energy Cycle Missions



The Water Cycle

Precipitation, evaporation, and condensation are all terms that sound familiar, yet may not mean much to you. They are all part of the water cycle, a complex process that not only gives us water to drink, fish to eat, but also weather patterns that help grow our crops.

Water is an integral part of life on this planet and that is why NASA plays a major role at the forefront of water cycle research. Currently, there are many NASA missions that are simultaneously measuring a myriad of Earth's water cycle variables; Evaporation, Condensation, Precipitation, Groundwater Flow, and Runoff. NASA's water cycle research missions can be grouped into 3 major categories; Water Cycle, Energy Cycle, and Water and Energy Cycle Missions. By studying each and every variable of Earth's water and energy cycles, "As Only NASA Can", a crucial understanding of the water cycle's effect on global climate is currently underway.

The Earth was formed approximately 4.6 billion years ago. During this formation, gases (water vapor and carbon dioxide) trapped in Earth's core were released by volcanoes, creating the atmosphere. About 800 million years later (3.8 billion years ago), oceans were formed on this planet. Once the Earth cooled enough for the water vapor to become liquid, the water vapor fell as rain, forming the oceans. Once the oceans were formed, the Sun's energy became the driving force of the water cycle. Over Earth's history, the oceans and continents have undergone great transformation, primarily due to an evolving water cycle. Since the evolving water cycle has an impact on everything from environmental concerns to human water demands, NASA realizes the crucial need for understanding all the impacting variables of the water cycle.

Only about 3% of Earth's water is salt-free, or fresh. Two percent of the Earth's water (about 66% of all fresh water) is in solid form, found in ice caps and glaciers. Because it is frozen, the fresh water in ice caps is not available for use by people or plants. That leaves about 1% of all the Earth's water in a form useable to humans and land animals. This fresh water is found in lakes, rivers, streams, ponds, and in the ground. It is also found in the atmosphere in liquid, solid and vapor form. Did you know that if you live in the United States, there are 40 trillion gallons (1.51416×10^{14} liters) of water above your head on an average day? Some of the water that falls to Earth soaks into the ground and provides runoff to rivers, lakes, and oceans. The remainder, more than 2.5 trillion gallons (9.4635×10^{13} liters), returns to the atmosphere through evaporation, and the cycle begins again.

The water cycle is a never-ending global process of water circulation from clouds to land, to the ocean, and back to the clouds. To give an idea of how fast or slow water moves through the global system, in the oceans, water takes about 3000 year to completely cycle through. For ice caps and glaciers, it may take up to 15,000 years while for the atmosphere it usually takes a few days. In rivers, the turnover is also a few days to weeks but groundwater flow can take hundreds to thousands of years.

To put some real numbers to this cycle, in the atmosphere, rivers, oceans, groundwater, and elsewhere on Earth there is a total of 326 million cubic miles of water (more than 326,000,000 trillion gallons [1.234×10^{15} liters]). Less than one percent of that total is our supply of drinking water. Recent estimates have put the global water demand at 800 cubic miles of water per year, or approximately 800 million Olympic-sized swimming pools per year!

Through NASA's water cycle research, we can understand how water moves through the Earth system in the hydrological cycle and we will be in a better position to effectively manage this vital renewable resource and help match the natural supply of water with human demands. NASA is the only national agency that has the ability to support a full range of water cycle research, from large-scale remote sensing to in-situ field observations, data acquisition and analysis, and prediction system development.

For the Classroom

Create Your Own Water Cycle Model - Introduction

On the Earth, water maintains a constant cycle of change and motion. This cycle, known as the Water Cycle or Hydrologic Cycle contains five major processes: evaporation, condensation, precipitation, groundwater flow, and surface runoff. This activity will allow the teacher and/or students to create their own working model of the water cycle using common materials found in a science classroom.

Materials

Aquarium or clear rectangular shoe/storage box; plastic wrap; modeling clay; desktop lamp; water (representing an ocean); ice cubes (whole or crushed).

Procedure

1. Previous to setting up the experiment, discuss with students the five major stages of the water cycle. As an extension to instruction, if classroom Internet access is available, please visit http://watercycle.gsfc.nasa.gov to download and discuss the "Water Cycle Movie".
2. Begin the construction of your "Water Cycle Model"
3. Mold the modeling clay into the shape of a mountain with a vertical side and a sloping side.
4. Place the clay mountain into the left side of the aquarium with the sloping side facing the interior of the aquarium where the majority of the "ocean" will be.
5. Pour water into the aquarium until approximately 1/4 of the mountain slope is covered.
6. Cover the top of the container with the plastic wrap, then place several ice cubes on plastic wrap directly above the clay mountain.
7. Position the lamp over the ice cubes and turn the lamp on. Please be careful, as the lamp will get extremely hot due to the time duration of this experiment.
8. Keep the lamp on for approximately 15-25 minutes (dependent upon size of bulb) and have students observe any changes occurring in the aquarium environment that are water cycle related.

Questions

1. Which of the 5 stages of the water cycle were you able to observe in this experiment?
2. What is the energy source in this experiment and what does it represent?
3. Was evapotranspiration demonstrated in this experiment? If yes, where? If no, how could we have demonstrated it?
4. Where in this experiment does condensation occur more rapidly? How do you know?

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