

**Topic:** Water Cycle

**Grade Level:** 5<sup>th</sup>

**Time:** 50 minutes x 3 (This lesson can take three to five days. The days listed within the lesson are suggestions and can be manipulated to serve the students' needs.)

## Standards

CCSS addressed:

- CCSS.MATH.CONTENT.5.MD.B.2 Represent and interpret data.
- CCSS.ELA-LITERACY.W.5.3 Write narratives to develop real or imagined experiences or events using effective technique, **descriptive details**, and **clear event sequences**.

NGSS addressed:

- 5-ESS2-1. Develop a model using an example to describe ways in which the geosphere, biosphere, **hydrosphere, and/or atmosphere interact**.
- Crosscutting Concept: A system can be described in terms of its components and their interactions. (5-ESS2-1)
- Science and Engineering Practices: Develop a model using an example to describe a scientific principle. (5-ESS2-1)

## Engaging Contexts

The lesson's hook feature will be the GRACE Data Over the United States, 2003-2012 retrieved from <https://youtu.be/nJVmBiAgVco>. Teaching students about the importance of our water cycle and water resources conveys the magnitude of these Earth processes in our lives. I selected the GRACE data as the lesson hook because it shows how the United States' water mass changed over a broad span of time spectacularly. When thinking about the water cycle, one tends to imagine a bedrock-to-cloud picture. The GRACE data is an amazing above-the-Earth representation of the water cycle. Seeing the water cycle as an active phenomenon will engage the student in more critically inspired thought processes.

## Justification

The subjects integrated in this science lesson are mathematics, ELA, technology, engineering, and social studies. In mathematics, students will be representing, analyzing, and interpreting data using the GRACE satellite data collected over a ten year span. The students will be writing a narrative about their experience as a water molecule traveling through the water cycle for the ELA component. For technology, they will observe the GRACE dataset and understand from where that data came, and will make a model of the water cycle in which the engineering component surfaces. In social studies, the students will have to use their knowledge of United States geography to engage in the data. Learning to read and interpret data on a table or map in a textbook teaches a small amount of students the skill. Making the data real by showing real-life models in real-life problems brings the skill closer to home and engages more students; they see the worth in learning the skill. Writing a narrative about a process in which the students

participated gives meaning to their writing. Technology and engineering work together as the students make their model of the water cycle so the students can see this process in action on a small scale. All these subjects working together in harmony for the students' understanding of the water cycle helps them to see how all of these subjects are relevant in their learning and how the work of a scientist involves knowledge of many disciplines.

### Objectives

- The students will describe the various components of the water cycle.
- The students will develop a model of the water cycle and describe how the process works.
- The students will write a narrative imagining themselves as a water molecule moving through the water cycle using clear details and sequential order words.
- The students will analyze, represent, and interpret data.

### Vocabulary

- evaporation
- precipitation
- glaciers
- watershed
- erosion
- sediments
- runoff
- groundwater
- transpiration
- condensation

### Lesson Procedure

\*The students will need to pair up with another student to look up the vocabulary words in a dictionary and write or draw the meanings of the words in their notebooks before engaging in the lesson.

### Engage: Day One

The teacher will introduce the lesson by playing the GRACE data map from <https://youtu.be/nJVmBiAgVco> on the projection screen (replay as needed). As the data plays through the years, the teacher will ask the students to write down observations in their notebook about what they are seeing. The teacher will ask the students to share the observations they have written down. The teacher will make sure the students notice the data's measurement scale (the color bar) at the bottom of the graphic, and help them make observations about the information it tells, as needed. After hearing their observations, if no one has been able to explain what they are viewing, the teacher will tell the students the data shows how water moved over the United

States between the years of 2003-2012. The teacher will ask the students if they know or can guess how this data was collected. If no one can explain, the teacher will tell them it was collected by NASA's GRACE satellite and show a picture of the satellite from [https://www.jpl.nasa.gov/spaceimages/images/largesize/PIA21607\\_hires.jpg](https://www.jpl.nasa.gov/spaceimages/images/largesize/PIA21607_hires.jpg) and that the data shows the water cycle happening from above the Earth. The teacher will ask the students what they know about the water cycle to assess prior knowledge. The teacher will write on the board the information the students give (right or wrong). The teacher will ask the students to draw a model of the water cycle in their notebooks as they understand how it works right now, including the words from their vocabulary that would be found in the water cycle (loosely model for the students how the landscape should look on their paper. Do not put words on the model on the board, for this is their assignment). Tell them they will may change these models during the next three days as they learn more about the water cycle. The teacher will give generalities of the water cycle by saying, "Water is constantly moving. In general, it evaporates from oceans into the atmosphere (air), condenses into clouds, falls as rain or snow, and eventually returns to the oceans through a drainage system of streams and rivers. This process is what is called the water cycle. Energy from the sun, which allows evaporation, and gravity are the driving forces that power the cycle. It is the gravitational force that GRACE measured and now GRACE-FO measures as it orbits the Earth and sends back data for scientists to interpret and make data maps like the one we saw. These measurements show us the water cycle happen from above the Earth." Ask the students why they think it is important for scientists to study the Earth's water cycle and wait for responses. The teacher will show the students the video [https://youtu.be/oNWAerr\\_xEE](https://youtu.be/oNWAerr_xEE) which will discuss more information about the water cycle and how it is important to everything that lives on Earth. As the students watch the video, they will record in their notebooks reasons why the water cycle is important to living things. The teacher will say, "We have seen why the data from GRACE is important for scientists to study. Today, we will take the data collected from GRACE and act like scientists reading, representing, and communicating information learned from the data using some of our math and social studies skills."

The teacher will tell the students this data map is called a heat map but it does not represent heat as the name would imply; heat maps represent the measurement of the amount of something, and in this case, it represents Earth's gravity field which indicate water mass changes. Split the class up into ten different groups, representing the ten years of data (one year per group). The teacher will replay the heat map animation, pausing at the beginning of the data set, January 2003. Ask students to identify their location on the map. Use online mapping software or a copy of a U.S. map, if needed. Continue playing the animation while students watch changes in their region. Pause several times and ask students to use the color bar below the map to state the numerical value of millimeters of water (mm-H<sub>2</sub>O) for the given month. Ask students to identify a region (such as Southern California, Eastern Texas, Central Washington, etc.) that is experiencing great changes over time. Replay the animation as needed. Use the U.S. map to identify a city within a region that is experiencing great changes over time. Replay the animation and pause at various points, asking students to estimate what is happening over time near the chosen city. (e.g., Is the water amount increasing or decreasing related to the previous month?) Ask students to explain how they know what is happening (Answer: The color bar below the map indicates the amount of equivalent water. Changing colors on the map indicate changing water amounts at that

location). Divide the class into groups and have each group mark the chosen city with a dot on each of their monthly maps. Project a U.S. map on a screen and mark the exact location so students can reference it. Be sure all groups have the same location pinpointed on their maps. Explain to students that they will be making a giant line graph of data for 2003-2012 as a class, with each group graphing all the months of one year. Provide each group with a sheet of graph paper, on which they will graph their points. Have each group label the months across the horizontal (x) axis at distance intervals agreed upon by the class. All groups should use the same scale so graphs can be easily combined. Agree on whether the paper should be oriented “landscape” or “portrait” so combining them at the end of the activity will be easier. Have each group label the vertical (y) axis at intervals appropriate for the task. Discuss that the y-axis should be labeled with a range that will accommodate the measurement of mm-H<sub>2</sub>O as indicated by the color bar at the bottom of the heat maps. All groups should use the same scale so graphs can be easily combined. Have groups plot their data and connect the dots with a straight line. Have students title their graphs appropriately. The title should include what is being represented by the graph (amount of equivalent water), the year and the location. Have groups present each year’s data and trends to the class. Have the students tape their graphs together on a wall or whiteboard, lining up the years in sequential order (optionally, create a new, larger class graph and have each group plot their data, connecting sequential points with a line. Use colored pencils to differentiate years). The teacher will use a rubric to assess student abilities and provide the students with feedback during the conference time (rubric and checklist provided below).

The teacher will ask, “What months does the gravity (water storage) increase or decrease?” Discuss seasonal differences and variation. As a class, examine the overall trends. The students will write about their experience in their journals with this prompt: What is happening at the location over the ten-year time span? Why do you think this is happening?

\*Conference with students after this activity.

### **Explore:** Day two

The teacher will help the students recall yesterday’s lesson and discussion on the water cycle. The teacher will ask the students if there are more players in the water cycle other than just clouds, oceans, rivers, and land and wait for responses. Depending upon the answers given, the teacher will make sure to include these statements:

- Living organisms are part of the water cycle.
- All living things need water to live because it is essential to their bodily functions.
- Plants and animals take in water and return it to the atmosphere as vapor (breathing, transpiring) or to the soil as liquid (excreting).
- Water is stored in the coldest regions on Earth, but it also plays a part in the water cycle.
- Ice and snow are in motion.
- Glaciers slowly melt as they move inch by inch, and icebergs break away from glaciers and float in the ocean, slowly melting as they move toward the equator.

The teacher will show the students this USGS interactive water cycle map from <https://water.usgs.gov/edu/watercycle-kids-int.html> and roll over the areas that were just discussed and briefly talk about each one. Show students how to manipulate the site and how to toggle between levels of skill (beginner, intermediate, and advanced).

The teacher will explain that the water cycle model is a simplified version of the journey of a water molecule and tell the students they will play a game in which they each will be a water molecule going on a journey. The students will use a score card (link provided below) to record the path they have to follow during the game. Divide students into seven groups (equally, if possible) and have each group begin at one of the seven stations (station card link provided below) distributed throughout the room (optionally, outside) with these labels: cloud, glacier, stream, groundwater, ocean, plant, and animal. Place a die at each station for the students to roll. They will roll the die and read the statement at their station corresponding to the number on the die. On their water cycle score card, they will write their current station stop, what happens to them, and their destination. The teacher will call out a signal word (“cycle” or another agreed upon signal word) and the students will go to the next station as directed on the paper and repeating the steps until the teacher observes the groups have cycled through the “cloud” station a couple of times.

**Explain:** Day Two (continued)

The teacher will ask the players to return to their seats with their score cards. Review with them sequencing words (first, next, after, before, while, during, etc.). Tell the students they will write a brief narrative from the water molecule’s perspective that describes the journey it just took through the water cycle using the sequencing words clearly and descriptive details of what happened during their travels through the water cycle, explaining how and why the molecule went where it did, and include the importance of the water cycle to living things (write these instructions on the board and read the example story provided below for guidance). Ask a few students to share their narratives. \*All students will need to turn in their narratives to be used as bonus points on the assessment. Then on the board, write the names of the seven stations in a circle and ask the students to look at their score card and tell all the different ways they got to the cloud. Have a student show each response by drawing arrows to the cloud from the other places they were. The teacher will ask and have students explain these questions: Even though individual molecules took different paths, was anything similar about the journeys they took? What makes the water move through the cycle (sun, gravity, physical properties of water)? What may happen if the sun’s energy were blocked from the Earth? How is the water cycle important to plants and animals (it moves water to them; water is needed for animal survival; it makes water available at different times)?

After these activities have been accomplished, the teacher will ask the students to take their models of the water cycle they drew at the beginning of the lesson and ask them if there are any changes they would like to make now they have seen the water cycle in action. Allow time for the students to make their changes. As students finish, they will be allowed to go to the

computers and manipulate the USGS water cycle map to see if their models they just made changes to match up with the interactive map.

<https://water.usgs.gov/edu/watercycle-kids-int.html>

### **Elaborate/Extend:** Day Three

\*The teacher will have the supplies for this activity placed on a table in the room for the students to gather when they are ready.

\*An example is provided below.

\*This is an outdoor activity. Plan this activity for a sunny day and know where your shady area is located.

The teacher will say, “We have seen a magnificent above the Earth display of the water cycle from GRACE’s dataset. We have also become water molecules going through the water cycle and have written narratives about the experience. We have even drawn models of the water cycle. Today we are going to conduct an experiment like a scientist would so we can see how the water cycle works.” Before the experiment, the teacher will assign five different groups and in their own words describe the water cycle to one another within their groups, correcting each other, as needed. While the students are discussing the water cycle, the teacher will provide the students with shopping lists of supplies they will need for their experiments (provided below) and listen to their discussions (checklist provided below).

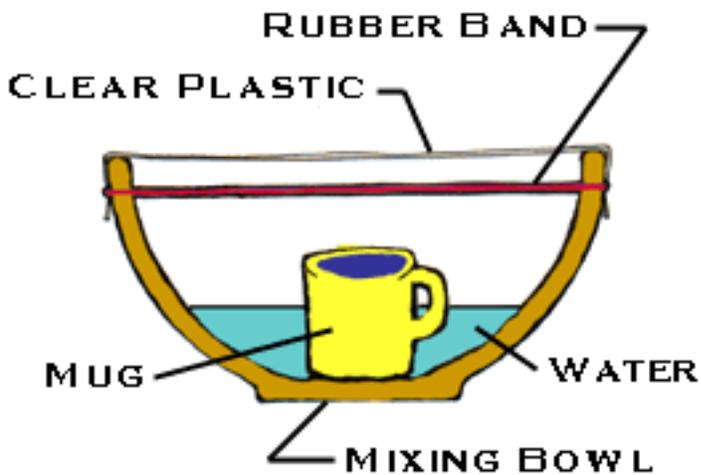
Staying within their groups, the students will gather the supplies they need from the table and take them outside along with their notebooks and pencils. The teacher will give them these directions:

1. Take your water bottles and pour water into your bowl until the water reaches the line marked on your bowl (the bowl will be  $\frac{1}{4}$  full of water).
2. Place the mug you chose in the center of the bowl (be careful not to splash water into the mug).
3. Cover the top of your bowl tightly with the plastic wrap you picked up, like your covering a dish to put into the refrigerator.
4. Put the rubber band around the upper area around your bowl to keep the plastic wrap in place and ensure a tight hold. If you need another rubber band, I have extras.
5. Watch and record in your notebooks what happens within your bowl.

A mist should form on the plastic wrap that should change into larger drops of water that will begin to drip. If the dripping does not start soon enough, carefully move the bowl to the shade. Continue to watch the dripping for a few minutes, then direct the students to carefully take the rubber band off and peel back the plastic wrap off the bowl. Ask the students if their mugs are still empty. Ask the students to describe what happened within their bowls in their notebooks (example answer: The water from the bowl evaporated and formed misty “clouds” on the plastic wrap. When the clouds became saturated it “rained” into the mug.).

\*Conference with students after this activity.

\*Example



### Evaluation

The teacher will use the checklists, observational, and oral assessments taken during the lesson to conference with the students to give them feedback on their learning. Give extra help or remediation as needed during the conferences.

**Formative:** The teacher will use checklists and use observational and oral assessments as the students complete tasks throughout the lesson.

**Summative:** The students will complete an end-of-lesson assessment to measure objectives. Narrative writing will serve as extra points on summative assessment graded by rubric.

### Lesson Materials

### General Materials

- students' pencils
- students' notebooks
- dictionaries (enough for pairs)
- journals

**GRACE Data Materials**

- colored pencils (optional)
- rulers
- graph paper
- data maps (one for each group) from  
[https://www.jpl.nasa.gov/edu/pdfs/grace\\_worksheets\\_2003-2012.zip](https://www.jpl.nasa.gov/edu/pdfs/grace_worksheets_2003-2012.zip)

**Water Cycle Game Materials**

- Water Cycle Score Card  
[https://www.plt.org/wp-content/uploads/2016/08/PLTPreK-8\\_Activity-44\\_Water-Wonders\\_Student-Page\\_Water-Cycle-Score-Card.pdf](https://www.plt.org/wp-content/uploads/2016/08/PLTPreK-8_Activity-44_Water-Wonders_Student-Page_Water-Cycle-Score-Card.pdf)
- Go to the Head of the Cloud station cards  
[https://www.plt.org/wp-content/uploads/2016/08/PLTPreK-8\\_Activity-44\\_Water-Wonders\\_Student-Page\\_Go-to-the-Head-of-the-Cloud.pdf](https://www.plt.org/wp-content/uploads/2016/08/PLTPreK-8_Activity-44_Water-Wonders_Student-Page_Go-to-the-Head-of-the-Cloud.pdf)
- 7 dice (one for each group)
- example story (provided below)

**Water Cycle Model Materials (one for each group)**

- a large metal or plastic bowl
- a sheet of clear plastic wrap
- a dry ceramic mug (like a coffee mug)
- a large rubber band
- a water bottle



### Story Writing: Water Molecule Narrative

Possible Score: 10

Student Name: \_\_\_\_\_

Score: \_\_\_\_\_ or  
\_\_\_\_\_ are

included  
potential  
not follow

accurate explanation of how and why the water molecule went where it did are included.

explanation of how and why the water molecule went where it did are included.

incomplete explanation of how and why the water molecule went where it did are included.

included. Did not follow directions.

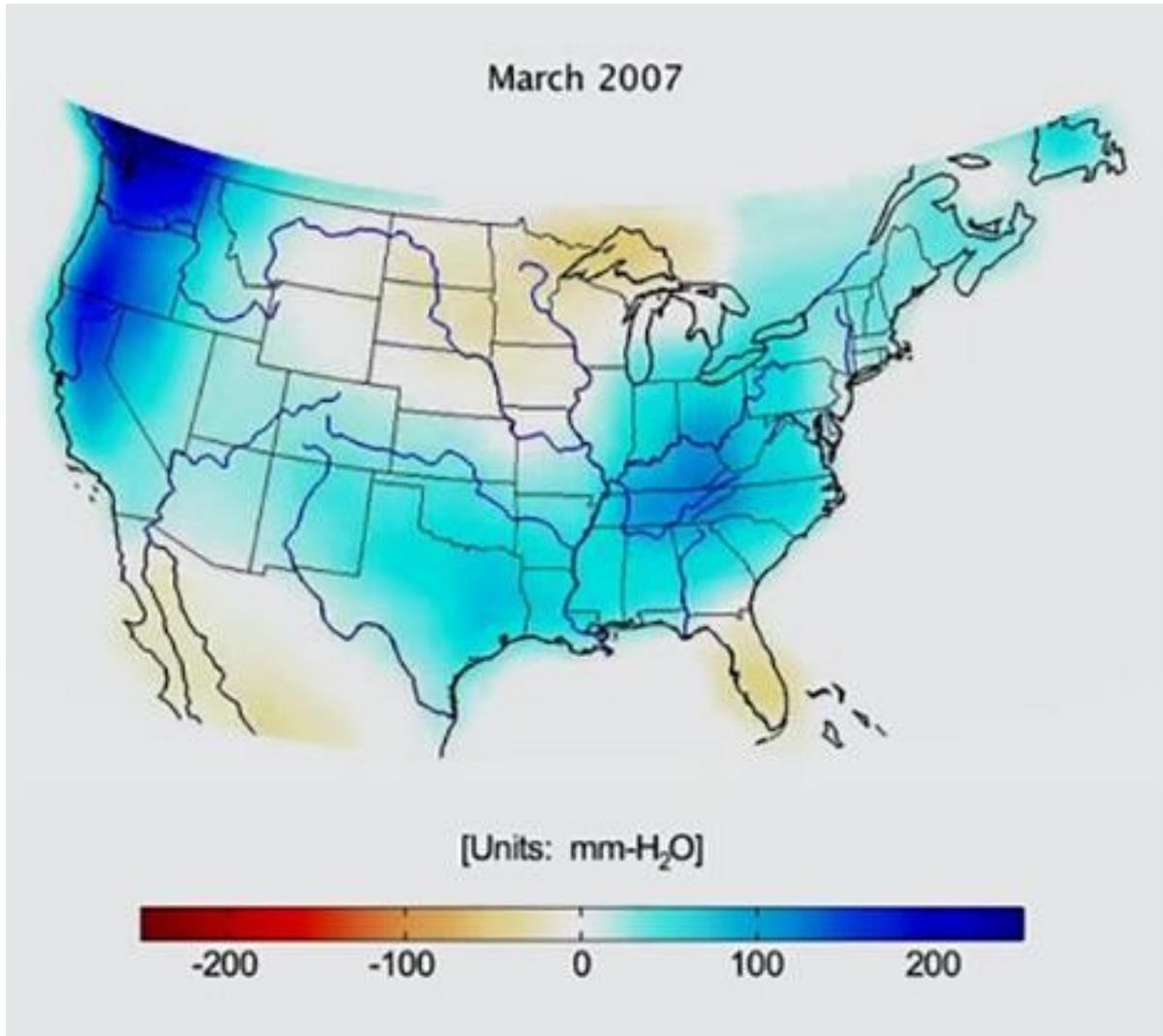
### Water Cycle Discussion Checklist

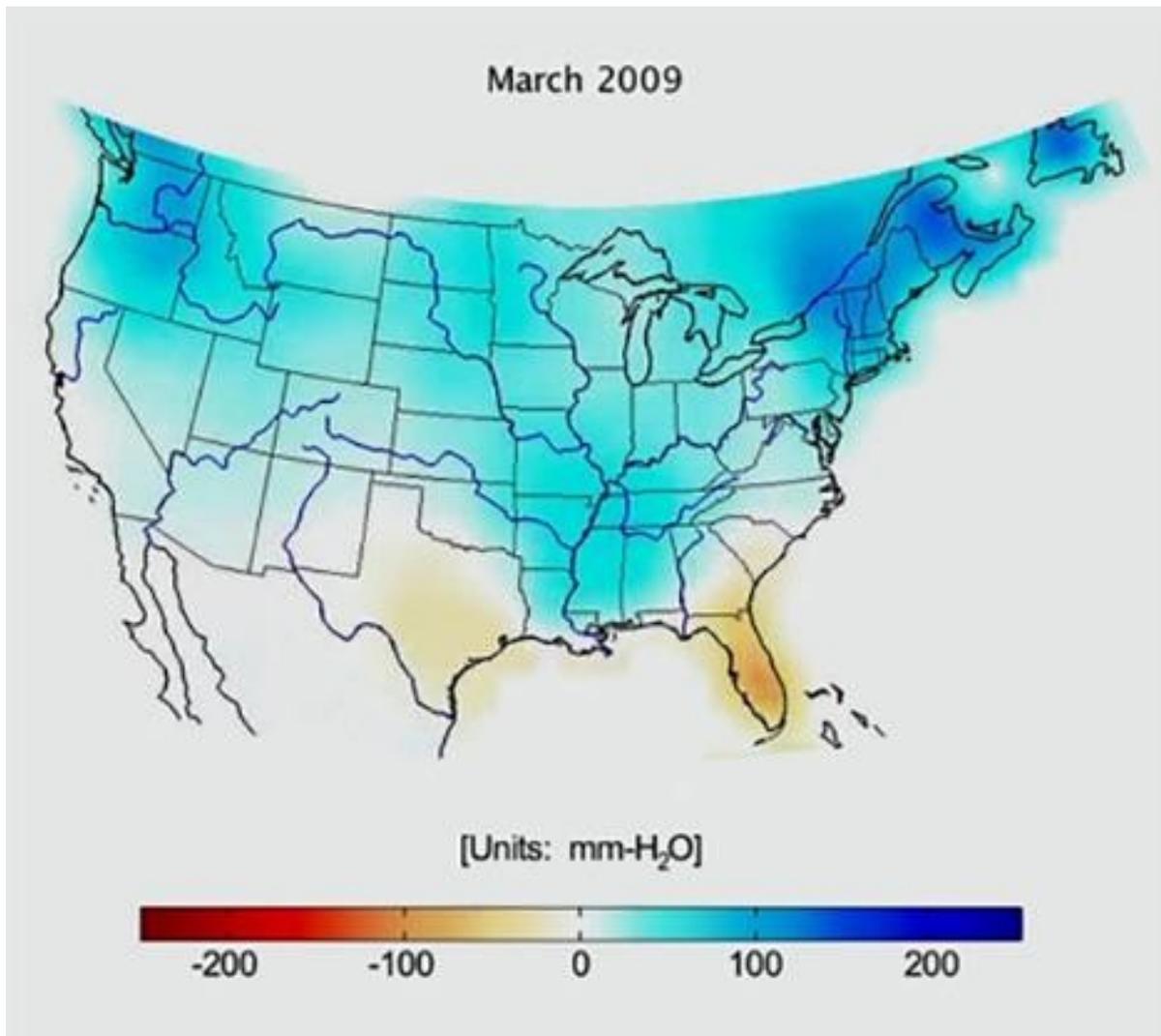
Student's Name	Contributed to Discussion (+ or -)	May need more help or remediation (□)



B. You created a real-life model and drew a model in class of the water cycle. Think about what you observed and drew. Use this area to describe the different components of the water cycle **and** how the process works. Use the back of the page if you run out of room.





(Example Story)

## Adventures of a Water Molecule

by Jon Kohl

I don't know what I did wrong, but it must have been a doozy. Of all the molecules that I could have become, I ended up as water. Instead of the stability of quartz or the short-and-sweet existence of ethyl alcohol, I cycled round and round traveling endlessly from the bottom of the ocean to the stratosphere and back again. I rained down, evaporated up, flew sideways from the mouth of a mammoth to the squirt of a squid. Trade winds carried me across oceans and continents. The never-ending sojourns spun my mind, whipping it frothy with weariness, never permitting a moment to stop and contemplate the places I have been. Some lucky water molecules bounce lightly on the ocean or float calmly in the air, but not me — never a restful decade.

How could any molecule ever earn her bearings always freezing, sublimating, transpiring, and precipitating at every opportunity? How could a nice water molecule like me ever find a place called home?

Then one day a strong gust grabbed me and threw me hard into a mountainside where I joined other molecules and dripped down smack onto an advancing glacier. There I stuck like a human child's tongue to a dry icicle—finally, a place to pause. Other snowy water molecules landed on top and within a few short millennia, I was buried half a mile down in solid ice. For me and the others there, our activity had come to a long awaited halt.

I had plenty of time to relax and reflect on the high-energy life I had once experienced. I remembered the time I washed down over Niagara Falls, the time I was blown clear out of a volcanic eruption, or the moment when, as a piece of hail, I splashed down directly in the path of the baleen of an oncoming humpback whale. I boldly went to the outer atmosphere where few water molecules had gone before and delved deep into a slow-moving, underground aquifer. Yet I escaped there, as well, in a matter of a few short decades when a geyser sneezed me into the sky.

Now that I think about it, I was quite the whirligig.

But that was then. Now I lie at the center of a glacier sliding through a mountain valley. Is this the peace I really wanted? Here I lay encased, serving out a sentence that may last thousands of years. As I remain frozen on the edge of a tiny air pocket, I begin to dream of places I have yet to visit and things that still remain for a water molecule to do: shimmer in a young rainbow, navigate the Mississippi from source to sea, cradle tadpoles in a pond as they transform into frogs, climb a cactus stalk from desert sands, pool in a pitcher plant lurking for insects in a bog, burst from a round blueberry between the prehensile lips of a bear, glisten in a happy human eye!

But wait. I've just learned something new. Through the lattice of chatty water molecules that whisper word from the freshly fallen snow, I hear that my glacier is flowing down the valley toward the coast. What luck! In a few more years, just when my restlessness would grow intense, my icy prison will break off the front of the glacier and fall into the sea. Then my iceberg will melt, and soon, I will be set free!

## Your Shopping List

\*Check the box after acquiring your item.

- one large metal or plastic bowl
- one sheet of clear plastic wrap
- one coffee mug
- one large rubber band
- one water bottle

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### Resources

\*These are resources not shared within the text.

- Adapted Project Learning Tree PreK-8 Activity Guide and online resources (www.plt.org): “Water Wonders” activity 44
- Adapted Engage data activity and data maps from <https://www.jpl.nasa.gov/edu/teach/activity/tracking-water-using-nasa-satellite-data/>
- Adapted Elaborate/Extend activity and example picture from <http://www.mcwa.com/MyWater/KidsWaterFun.aspx#cycle>