Climate101 Week 6

Water Cycle and Start Carbon Cycle

Overview of the Week
* Participants make models at different scales to compare the volumes of a cubic centimeter, a cubic meter, and a cubic kilometer.
* A double jig saw activity facilitates explorations and discussions of different reservoirs of the water cycle and how water flows between those reservoirs.
* Participants review key ideas about carbon using Session 2.1 of the Ocean Sciences Sequence
* Participants write their initial ideas about the carbon cycle, and compare the main features of the water cycle and the carbon cycle.
* Participants explore the PCEP Carbon Cycle Interactive in a computer lab.

Before Teaching this Week:
* Make a cubic meter out of cardboard to show class
* Make color copies of *Dr. Art's Guide to Planet Earth* pages 26-31 for each participant (PDF includes pages 32-33 that you do not need to photocopy)
* Make handouts for each participant of:
    - Learning with Visual Features About the Water Cycle (do not include instructor pages) plus one copy for each group
    - "Make Two Cubes"
    - "Names of Big Numbers"
    - "First Ideas About Carbon"
    - "Reservoirs of the Carbon Cycle" (color)

*Review these instructions, the slides, the handouts, and the reading.

Other Materials Needed:

Metric rulers, scissors, scotch tape and index cards or business cards for five groups to make two model cubes (one that is 1cm x 1cm x 1cm and a second one that is 2cm x 2cm x 2cm)

Day 1:
Hand out the reading "Earth's Liquid Stuff" from Chapter 2 of Dr. Art's book. Each participant should get a color copy of this reading.

Show Slide 1 (Systems Within Systems Within Systems). Tell participants that this week we are going to focus on the water cycle. In other words, we are studying the hydrosphere.

Ask different participants to explain the meaning of the phrase "systems within systems within systems." Reinforces that any system is made of parts, and each of those parts is itself a system that is made of parts.

Start with the phrase in red that defines the hydrosphere. Point to the sentence above the red sentence. Ask everybody to tell a person next to him/her what they think X is. Get a sample of answers (*Earth's Matter).*

Now ask everybody that if X is Earth's Matter, point to the first sentence and ask what could Y be. Ask them to tell a different person what they think Y is. Get a sample of answers (*Planet Earth or the Earth System).*

Now point to the sentence below the last sentence. Ask for volunteers to name some of the parts of the hydrosphere. You can write their suggestions on a chart or display it from a computer.

Show Slide 2 (The Hydrosphere). Point to the fourth bullet that lists some of the parts of the hydrosphere. You can compare with the list they said. Note the new vocabulary word in the last bullet. Ask if they are familiar with that word. Help with the pronunciation. The spelling and pronouncing are a little strange because it comes from a word in the French language.

Either read aloud or have different people take turns reading aloud the first two paragraphs on page 26. Finish by reading the first sentence in the third paragraph.

Show Slide 3 (Names of Different Sized Numbers). Give out the Names of Big Numbers handout. Have them work in small groups for at most 5 minutes to fill out the chart. They can use numbers from the right-hand column of the chart on page 27 or that are near the drawing on the bottom right of page 27 of their water cycle reading from Dr. Art's book. Do not include numbers that are in the percent column of the Table.

Have participants follow directions on the handout. Call on different groups to get their examples, and how the numbers are pronounced. Are there numbers in the chart that do not have local language words? When they say the English numbers, help them always include the units at the end (e.g., thirteen thousand cubic kilometers or six point eight milliliters).

Show Slide 4 (Make Two Small Cubes). Say that now we are going to review the metric units of measurement that we are using. Give them the handout "Make Two Cubes" for working in groups of three to make the two cubes. They will need rulers that have centimeters marked on them. Hand out index cards (or something like it), rulers and scissors and have them work in groups to make two model cubes (one that is 1cm x 1cm x 1cm and a second one that is 2cm x 2cm x 2cm). Keep the slide visible while the groups work on making the two cubes.

Ask them how much bigger they think the second cube is compared to the smaller cube that they made. If they have problems, you can remind them that the volume is calculated by multiplying the length times the height times the width. The correct answer is that it is 8 times bigger (two times two time two).

Show Slide 5 (How Big Is A Cubic Meter?). Either show the slide so you reveal one bullet at a time or you are able to hide the lower bullets until you are ready to reveal one bullet at a time. Show the cardboard box that you made that is one cubic meter (one meter long in all dimensions).

Say that the volume of the small cube is 1 cubic centimeter, which is also called one milliliter. Hold up a 1 liter bottle and say that its volume is 1,000 cubic centimeters. A liter is a thousand times bigger in volume than a cubic centimeter.

Point to the first line of the slide to remind them that a meter is 100 cm. The cubic meter box is 100 times as long in each dimension than the cubic centimeter very small cube that they made. *Correct answer is a million times bigger. 100 times bigger on each side means that the volume is 100 times 100 times 100 bigger = one million times bigger. You could fit a million of their cubic centimeter boxes in your cubic meter box.*

Show Slide 6 (How Big Is A Cubic Kilometer?). Either show the slide so you reveal one bullet at a time or you are able to hide the lower bullets until you are ready to reveal one bullet at a time. Point to the second bullet on the slide and get estimates of how much bigger the cubic kilometer box is. *Correct answer is a billion times bigger. 1000 times bigger on each side means that the volume is 1000 times 1000 times 1000 bigger = one billion times bigger. You could fit one billion of their cubic centimeter boxes in a cubic kilometer.* A cubic kilometer would hold 1 billion times more water than your cubic meter box. And the ocean has more than a billion cubic kilometers of water in it.

Show Slide 7 (Could We Make A Cubic Kilometer Box?). If not in RMI, contextualize the slide for your own location.

<u>Day 2:</u>
Show Slide 8 (Visual Features in Books). Remind participants that when we first looked at the PCEP Weather Climate Booklet (Week 1) we analyzed visual features to help make them easier to understand. Today we will practice using that literacy strategy. Give them up to 5 minutes to discuss in pairs and find four different kinds of visual images in the "Earth's Liquid Stuff" reading. Call on people to share the visual features that they noted. Make sure they include the photo with text (page 26); section headings (pages 26 and 28), charts or tables (pages 27 and 30), and drawings or illustrations that include numbers and/or words (pages 27, 28 and 31).

Show Slide 9 (Interact With A Visual Feature). Explain that they will work in 4 groups to analyze the visual images in the booklet. Divide the class into four groups and give each group the handout called "Learning With Visual Features About the Water Cycle." Have each group write at least one question about their assigned visual feature before reading their section. Help each group complete their assignment.

Show Slide 10 (Jig Saw Activity). Follow directions to have each group member join a new group. Their role in the new group is to serve as an expert on their visual feature and to explain to the other members of the new group about their visual feature. In this way, everyone gets to be an "expert" and also a learner in the new group that hears and discusses reports about each of the four visual features.

After the new mixed groups have finished their discussions, lead a whole group discussion about what is hard for people about each of those visual images, and what is helpful for people about each of those images. Reinforce the main water cycle concepts and also how the participants can help their students with interpreting these kinds of visual features.

Show Slide 11 (Reservoirs and Flows Of The Water Cycle) Use this slide to summarize the main content ideas about the water cycle.

Show Slide 12 (First Ideas About Earth's Carbon Cycle). Distribute the First Ideas handout and introduce the assignment. Have each person individually write his/her first ideas about the carbon cycle. Say that this is not being graded. Whatever they know or think they know is fine. Collect their first ideas, and photocopy them during a class break. Return and give them back their first written ideas. You can use the photocopies for formative assessment and for their own self-reflection later in the course after they have learned much more about the carbon cycle.

After the break and redistributing their First Ideas write-ups, have participants work in groups to compare and summarize their first ideas about the carbon cycle. Call on groups to share their ideas, and highlight what seem to be common understandings and areas where there may be significant questions or disagreements.

Transition to Session 2.1 to make sure there is a basic and shared foundation about the element carbon and its interactions. Do not do the "First Ideas about Carbon" that is in Session 2.1. Use the version that is included here.

Then continue in Session 2.1 with page 150 of the Teacher's Guide. **Show Slides 13 (Finding Out about Carbon) through Slide 17** to introduce the topic of learning more about carbon on Earth. Use "Turn and Talk" to have the participants discuss in pairs and share with the class about the questions that are in the slides**.**

Show Slide 18 (Finding Carbon in a Chemical Formula) to introduce the main activity involving the 20 Carbon Cards. Follow the instructions on pages 152-153 for the "Sorting Carbon Cards" activity. **Slide 19** summarizes a Key Concept about carbon on our planet.

Show Slide 20 (Carbon Cycle Reservoirs). Distribute the color handout of this slide. Tell them to keep this where they can keep referring to it over the next weeks. Tell them that the numbers are billions of tons (also called gigatons). The 800 gigatons of carbon in the atmosphere is equal to 800,000,000,000 (800 billion tons), and it is almost all in the form of carbon dioxide. A ton is two thousand pounds, so this amount in pounds would 2,000 times 800,000,000,000 billion pounds. That is a huge amount of carbon in the atmosphere, but it is also much less than the carbon in some other reservoirs.

Have them volunteer to describe things they notice. Write their comments on a board or chart paper or projected computer screen. Things to point out:

Largest reservoir is Rocks which is 60 million gigatons. The form of carbon in rocks is solid carbonate as in calcium carbonate (limestone). While the rocks are the largest reservoir, the carbon in rocks is comparatively very stable and stays in rocks for very long times. The flow rates of carbon into and out of the rock reservoir are very small compared with the flow rates into and out of the other reservoirs
Ocean is next largest reservoir with 41,000 gigatons. Most of that carbon is a dissolved salt called bicarbonate (like in baking powder). The amount of carbon in ocean organisms is very small compared with the amount of bicarbonate salt.
Land biomass has about 2,500 gigatons. Soil and Plants have a lot more of this organic carbon than animals.
Fossil fuels have about 10,000 gigatons, in fossil fuels (oil, coal, and natural gas). Fossil fuels are buried under the ground.

Introduce the concept of carbon flowing between reservoirs by showing the studio version of the carbon cycle in the *Dr. Art Does Science* DVD. Say that the next class session will provide opportunities to explore the carbon cycle in more depth with a computer interactive.

Day 3: In computer lab
Show Slide 21 (PCEP Carbon Cycle Interactive). This interactive is the source of the information in the previous slides. Go to and project the PCEP Carbon Cycle Interactive on PBS Learning Media at:

http://www.pbslearningmedia.org/resource/pcep14.sci.ess.co2cycle/carbon-dioxide-carbon-cycle/

Participants explore the interactive either by having it available on their computers via PCEP thumb drives or by accessing it via the internet. Participants work in teams to take notes about what they have learned and also to raise any questions that they have.

Show Slide 22 (Reservoirs and Flows of the Carbon Cycle). In a whole group discussion, compare these summary statements with their first ideas about the carbon cycle. Ask if the same statements would be true about the water cycle. If a

statement would not be true about the water cycle, how would it need to be modified in order to be true about the water cycle.

If there is enough time, show a carbon animation that is on YouTube at:

http://www.youtube.com/watch?v=ypbb9Zi5Tao

Unfortunately, the captions are not very good, so it is probably best to **not** turn the CC on. Also only show Episode 1. The other episodes have some significant science inaccuracies.