Using Balloons to Model the Carbon Cycle

Purpose: The carbon cycle is perhaps the most important of Earth's matter cycles. Not only is it vital for life (photosynthesis and respiration), it plays a key role in Earth's global climate because atmospheric carbon dioxide contributes significantly to Earth's greenhouse effect. By participating in and viewing a physical simulation of the carbon cycle, a group can gain a deeper understanding of the reservoirs and flows of the carbon cycle.

Equipment and Supplies:
Demonstration Mode - At least 20 black balloons to represent carbon. Two other balloons, each of a different color (e.g., blue and white). These can be filled with air or helium. String and weights for balloons (especially if using helium!). Signs to identify the principal carbon reservoirs (Atmosphere; Land Biomass; Ocean; Fossil Fuel; Rock).

Procedures:
1. Introduce the carbon cycle. Discuss why it is important and why it is harder to understand than the water cycle. Reinforce that whenever we examine a cycle of matter, it is useful to investigate the different reservoirs and flow rates. Explain that we are representing the amounts of carbon in each reservoir using balloons.

2. Assign 5 different locations within a room for the different carbon reservoirs. These should be close enough for visual comparison and to easily move balloons from one reservoir location to another. Place identifying signs in each location, and have a volunteer sit in that location. A physical or other graphic representation of that reservoir (e.g., a picture of the sky, a plant, a big rock, etc.) can enhance the presentation.

3. Explain that one balloon represents all the carbon in the Atmosphere (about 800 Gigatons). Elicit what form that carbon is in (carbon dioxide gas). Place one black balloon with the Atmosphere location volunteer.

4. Have participants estimate how many balloons should be used to represent the carbon in the Land Biomass reservoir. Place 3 black balloons there. Discuss the form of the carbon (cellulose, starch, sugar, protein, etc.). Discuss how the carbon got there (photosynthesis).

5. Have participants estimate how many balloons should be used to represent the carbon in the Ocean reservoir (answer - 48 balloons). Place 8 black balloons and one big blue balloon there. The big blue balloon is representing 40 black balloons. Discuss the form of the carbon (bicarbonate salt resulting from the absorption of carbon dioxide in ocean water).

6. Announce that there are 12 black balloons located under the Earth representing oil, coal, and natural gas (Fossil Fuels). These should be on ground level, perhaps hidden in boses or bags. Discuss the form of the carbon (solid coal, liquid hydrocarbon petroleum, and gas hydrocarbon methane). Discuss how the carbon got there (photosynthesis hundreds of millions of years ago and subsequent burial). Note that Fossil Fuel carbon normally does not significantly go into or out of the Atmosphere.

7. Remind participants that Rocks are the hugest carbon reservoir. Place 1 white balloon in the Rock location. We are using one big white balloon to represent about 70,000 black balloons. Discuss the form of the carbon (solid carbonate as in limestone). Carbon in Rocks moves very, very slowly into and out of the Atmosphere.

8. Now change the focus from the amounts/kinds of carbon to how it flows from one reservoir to another. For *natural* flows into and out of the air over decades or even a century, we can focus just on flows involving the Land Biomass and involving the Ocean.

Take the Atmosphere balloon and add it to the Land Biomass reservoir. Say that over the course of six years, all the carbon in the Atmosphere goes into Land Biomass via the process of photosynthesis. Ask and discuss why we still have CO_2in the Atmosphere (over a six year period one balloon amount of carbon returns to the Atmosphere from Land Biomass via the processes of respiration and decomposition). Bring a black balloon from the Land Biomass reservoir back to the Atmosphere reservoir.

9. Take a black balloon from the Atmosphere reservoir and add it to the Ocean reservoir. Say that over the course of 7 years, all the carbon in the Atmosphere dissolves in the Ocean. Ask and discuss why we still have CO_2 in the Atmosphere (over a 7 year period one balloon amount of carbon returns to the Atmosphere from the Ocean via evaporation of CO_2). Bring a black balloon from the Ocean reservoir back to the Atmosphere reservoir.

10. Inflate a black balloon by blowing into it and walk over to the Atmosphere volunteer. Discuss how humans have been un-burying Fossil Fuels and burning them, thereby releasing carbon dioxide into the Atmosphere. Show that today's Atmosphere has 50% more carbon dioxide than the pre-industrial Atmosphere. Illustrate that the amount of carbon dioxide in the Atmosphere is projected to double in about fifty years.

11. Review the reservoirs of the carbon cycle and how carbon flows into and out of them. Discuss why people care about the increase in CO_2 in the Atmosphere (enhanced greenhouse effect leading to more global climate change).