Activity 10: The Incredible Carbon Journey

What You Will Do: Play the Carbon Journey Game

(Adapted from an activity by members of the Kentucky Association for Environmental Education [kaee.org])

Big Idea

Human activities have changed the way that carbon is distributed in Earth's atmosphere, lithosphere, hydrosphere, and biosphere.

What You Will Need

A large room or outdoor area where you can play the game

1 – Adult Partner

Several partners to play the game

Pony beads, regular (8/0) size, in blue, green, clear, and black colors; at least six of each color for each Player in the gam (search the Internet for "pony bead;" also available in some craft stores)

Signs for four game stations: Lithosphere, Atmosphere, Hydrosphere, and Biosphere

Four plastic bowls to hold the Pony beads for each station

White chenille craft sticks (pipe cleaners), about 12 inches long; two for each Player

Five paper Game Cubes made from patterns at the end of this Activity

Clear plastic tape

Scissors

Copies of "Incredible Carbon Journey Game Record," one for each Player

The element carbon is one of the most basic building blocks of life on earth. It is found almost everywhere—in plants, animals, pencils, diamonds, soil, and even soda pop. Carbon is able to easily bind with other atoms to form different chemical compounds; this is why carbon exists in so many forms. Carbon can dissolve in water, form chains of atoms to create sugars, and form solid materials like coal and limestone. Carbon in living things can be released through respiration, consumed as food, or transformed into fossil fuels over millions of years. In the atmosphere, carbon exists mainly as carbon dioxide. Carbon dioxide is called a greenhouse gas because it can trap some of the sun's heat in the atmosphere. Without carbon dioxide's natural ability to trap heat in the atmosphere, life as we know it could not exist.

Carbon on Earth is found in the atmosphere, soil and rocks (the lithosphere), water (the hydrosphere), and in living organisms (the biosphere). The activities of living organisms, volcanoes, weather, and many other processes can cause carbon atoms to move from one place to another. This pattern of movement is called the carbon cycle.

Burning fossil fuels breaks the bonds that hold carbon atoms together inside those fuels, and carbon is released into the atmosphere. Scientists have found that the concentration of carbon dioxide in Earth's atmosphere has increased nearly 35% since the beginning of the industrial revolution. Methane, another compound that contains carbon, has increased by 150%. Earth's average global temperature has also increased by more than one degree Fahrenheit over this time period. This sounds like a small increase, but it is enough to cause major changes to earth's climate and ecosystems. Most climate scientists agree that earth's rising temperature is largely due to the increase in carbon dioxide and other greenhouse gases in the atmosphere resulting from burning fossil fuels.

How It Works

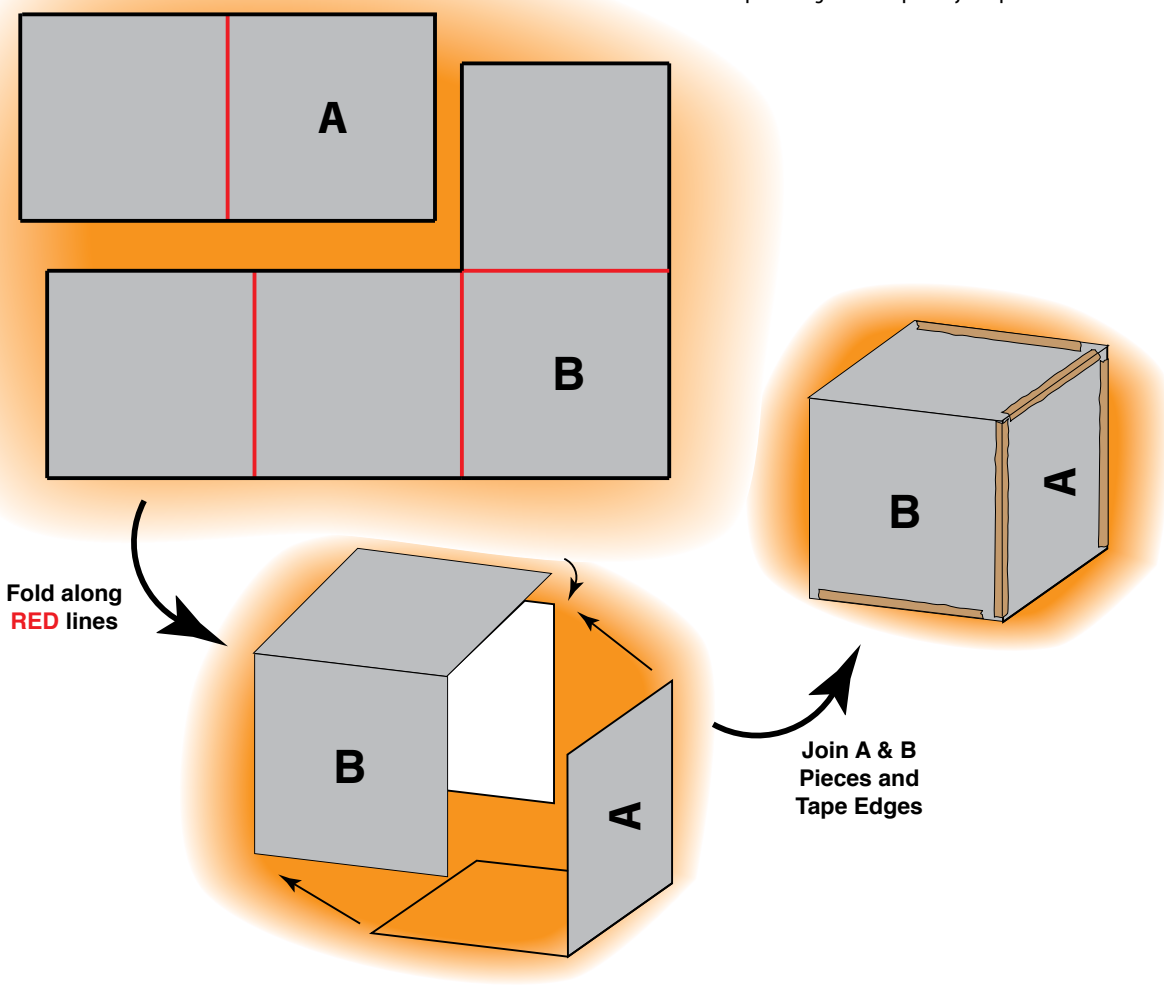
This activity is a way to compare the carbon cycle before the industrial revolution with the carbon cycle after humans began burning large quantities of fossil fuels. This is a great way to communicate important ideas about climate science and the carbon cycle.

How to Do It

1. Read through all of these steps before you start! Make a copy of the Record on page 48 for each Player. Photocopy pages 43 - 47 onto card stock for the cubes. Make the Game Cubes by cutting two pieces for each Cube from the photocopies of pages 43 – 47. Fold and assemble the pieces to form the Cubes as shown in Figure 1. Tape all of the edges where part A joins part B.

2. Each Player will begin at one station as chosen by the Player or Game Leader. There can be more than one Player at each station. The Game Leader places one of the cubes and one of the plastic containers at each station, then puts the green beads in the container at the Biosphere station, the blue beads in the container at the Hydrosphere station, the clear beads in the container at the Atmosphere station, and the black beads in the container at the Lithosphere station.

Figure 1. Make the Game Cubes
Fold along solid red lines, then bring the two pieces together as shown. Tape all edges where part A joins part B.



3. The Game Leader gives one pipe cleaner and one Game Record to each Player. Have the Player twist a knot or small loop onto one end of the pipe cleaner, and write the name of their starting station on the Game Record.

4. The Game Leader tells the Players they will represent carbon atoms in the carbon cycle. They will travel around the Earth following the journey of a carbon atom in the pre-industrial world – before we began burning lots of fossil fuels.

5. When the Game Leader says, "Go!" each Player places one bead from their station on the pipe cleaner.

6. Each Player rolls the cube at their station to find out where to go next. The Player then moves to the station shown on the cube, and records the name of the new station on the Game Record. If the cube says, "STAY", the Player goes to the back of the line for that station and waits to roll the cube again. While they are waiting to roll the cube, they should take another bead from the station and put it on their pipe cleaner.

7. Each time the Player moves to another station, they do the same thing: Take a bead, roll the cube, and move to the next station (or go to the end of the line and repeat), and record the name of the next station on the Game Record.

8. Players move from station to station for at least 10 minutes or long enough for Players to begin stacking up in the lithosphere line. This may take up to 15 minutes.

9. When most Players have visited the lithosphere several times, the Game Leader says, "Stop." Wherever Players are in line, they should take a bead from that line without rolling the cube and then sit down. This is the end of round one.

10. Ask the Players what color beads they have on their pipe cleaner and what happened to them during their trip. Did they see any patterns? For instance did they stay at any place more than once? Did anyone go back and forth between two stations (for example, biosphere and atmosphere)? What may explain this? Instruct Players to make a bracelet out of their pipe cleaner by twisting the end through the loop on the other end.

Game Leader Tip:

After round one, many Players will have a high portion of black beads on their pipe cleaners. This represents coal, natural gas, oil—all carbon molecules in the lithosphere. Deposits of carbon have accumulated over time from the remains of plants and animals. Over millions of years, these deposits have become transformed into fossil fuels.

11. The Game Leader exchanges the Pre-industrial Lithosphere (L1) cube for the Post-Industrial Lithosphere cube (L2).

12. The Game Leader gives each Player a new pipe cleaner, and says that they are moving into the Industrial Age. This is the beginning of Round 2. Players should twist a loop into the end of the pipe cleaner before proceeding.

13. Have Players pick a station at which to begin their journey.

14. Again, Players pick up a bead from their station and roll the cube. They will move from station to station again for at least 10 minutes or long enough for Players to begin stacking up in the atmosphere line. This may take up to 15 minutes. Each time the Players change stations, they should record the name of the station on the Game Record.

15. When most Players have visited the atmosphere several times, stop round 2. Wherever Players are in line, they should take a bead from that line without rolling the cube and then sit down.

Ask the Players what kinds of beads they have on their pipe cleaner and what happened to them in their trip/journey. How did this second round compare with their first journey through the carbon cycle? Did anyone find himself or herself "stuck" in one place? What may explain this?

Game Leader Tip:

Although the amount of carbon in the atmosphere has increased significantly over the last 150 years, it's important to emphasize that the amount of carbon on the earth has not changed. Carbon has simply moved from one place to another.

Although you cannot predict exactly what combinations of beads the Players will put on their pipe cleaners, you can be fairly certain that after the second round, more of the beads will be from the atmosphere. This represents the build-up of carbon dioxide in the atmosphere that is a direct result of the burning of fossil fuels.

If lines at a station get really long, this activity works best if Players take their beads before they arrive at the cube. If you have volunteers, station them along the longest lines of Players and have them distribute the beads while the Players wait their turn to roll the cube. It may also help to have two cubes for each station to minimize the wait time.

Want To Do More?

Players may create a storyboard, poster, or cartoon about their journeys through the carbon cycle. Players may research and record the processes involved in getting them from one place to the next in the carbon cycle. Did they notice any patterns in the beads on the pipe cleaners? For example, an alternating green-clear bead pattern could represent the cycling of carbon between plants and the atmosphere.

Players may graph the numbers of visits for each of the four spheres in the pre-industrial and post-industrial cycles, and create a master graph that incorporates the data from everyone's journeys in the pre-industrial and postindustrial cycles.

For an animated description of the carbon cycle, go to *http://epa.gov/climatechange/kids/basics/today/carbon-dioxide.html*.

For more information, contact Roberta M. Burnes (Roberta.Burnes@ky.gov), Environmental Education Specialist, Kentucky Division for Air Quality, Frankfort, KY

Incredible Carbon Journey Game Record

Record your journey through the carbon cycle on this page. Beginning at one end of your pipe cleaner, write the "sphere" you visited for each bead on the pipe cleaner.

Green beads = Biosphere

Blue beads = Hydrosphere

Clear beads = Atmosphere

Black beads = Lithosphere

Round 1: Pre- Industrial	**Round 2: Post- Industrial**
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.
11.	11.
12.	12.

After completing both rounds, answer the following reflection questions:

1. How do the two rounds compare?

_____

_____

2. What contributed to this difference?

_____

_____

3. Based off the data you collected in this activity, how would you describe the carbon cycle?

_____

_____

_____

Station	Die Side Labels	Explanation
Biosphere	one side ***stay***	Carbon is used by plants and animals and remains in the cells.
	two sides ***lithosphere***	Carbon enters the soil when plants and animals die.
	three sides ***atmosphere***	Carbon is released through decomposition, fire, and respiration.
Hydrosphere	three sides ***stay***	Carbon remains in oceans and other bodies of water.
	one side ***lithosphere***	Carbon precipitates as sediment and settles to the bottom of the ocean.
	one side ***biosphere***	Carbon is absorbed by marine plants during photosynthesis. Marine animals absorb carbon by eating the plants.
	one side ***atmosphere***	Carbon is released into the atmosphere from the ocean and other bodies of water.
Atmosphere	two sides ***stay***	Carbon remains in the atmosphere.
	two sides ***hydrosphere***	Carbon is absorbed by the ocean and other bodies of water. Cool water abosorbs carbon faster than warm water.
	two sides ***biosphere***	Carbon is absorbed by plants during photosynthesis.
Pre-Industrial Lithosphere	five sides ***stay***	Carbon remains in the soil as organic matter and in sediments containing fossil fuels.
	one side ***atmosphere***	Carbon is released through decomposition of dead organic matter in the soil, and through the metabolic processes of soil microbes.*
Post-Industrial Lithosphere	two sides ***stay***	Carbon remains in the soil as organic matter and in sediments containing fossil fuels.
	four sides ***atmosphere***	**Burning fossil fuels releases carbon dioxide.** Carbon is also released through decomposition of dead organic matter in the soil, and through the metabolic processes of soil microbes.*

* Although decomposition and soil microbial processes are biological, because they happen in the soil they are considered part of the lithosphere.

The Carbon Cycle

101.5 Pg/year = 101.5 Pg/year

\+ 6 Pg/year

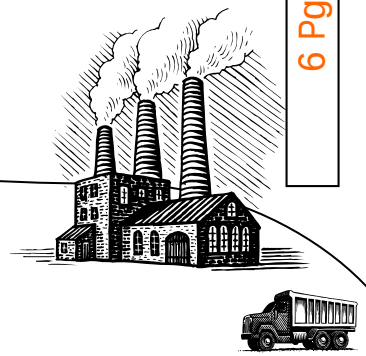
Fossil Fuel Combustion and Industrial Releases:

Upsetting the Balance

Released but not stored/ sequestered

92 Pg/year - 90 Pg/year

Terrestrial Carbon:
Equally released and stored by plants and animals



Photosynthesis absorbs CO_2 that is generated through respiration

=

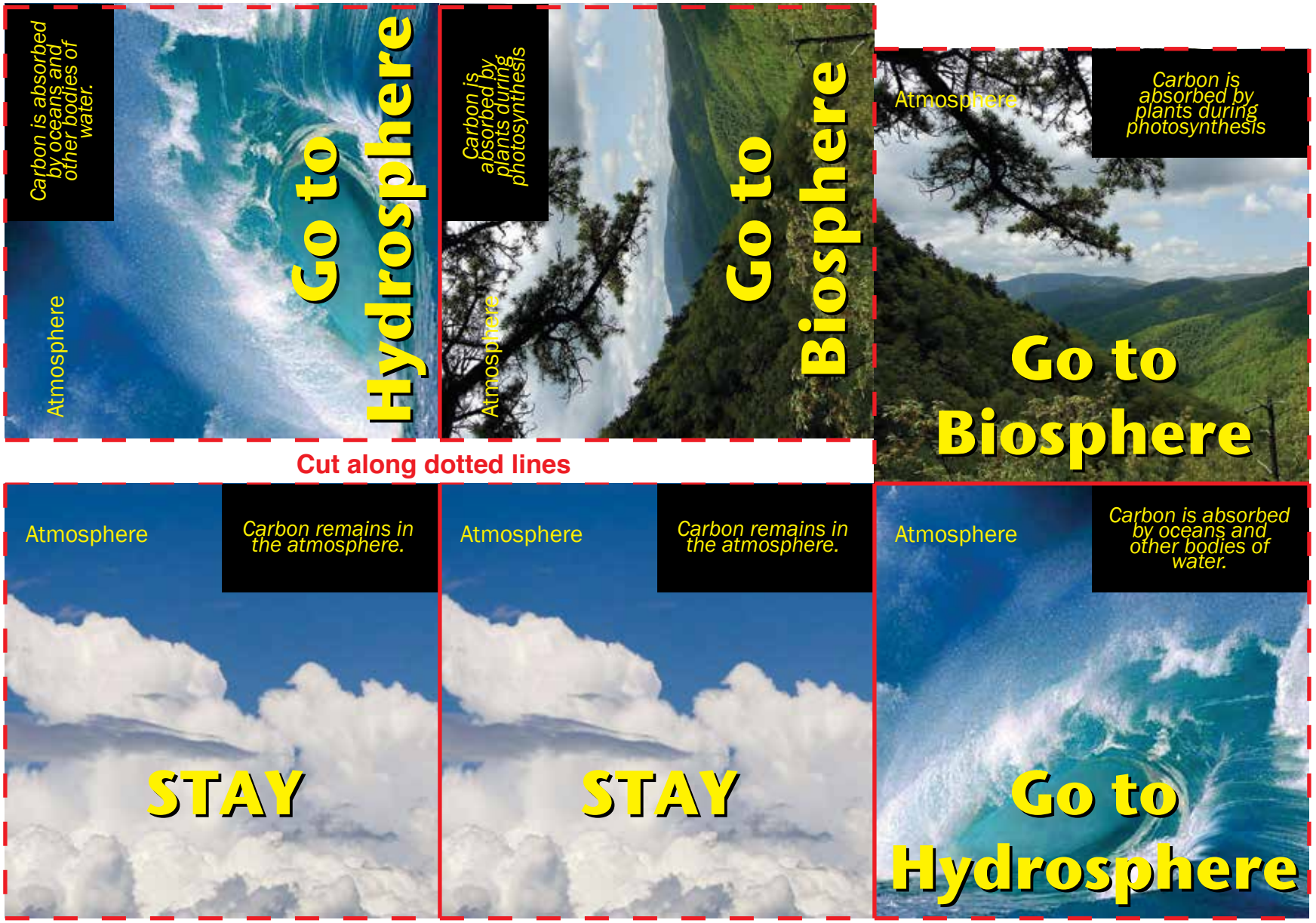
Human Respiration releases CO_2:
.000000002 Pg/year

Oceanic Carbon:
Oceans hold more carbon than they release; warming oceans are less able to absorb carbon

Sources: United Nations Environment Program, Carbon Dioxide Information Analysis Center, U.S. Environmental Protection Agency, KY Division for Air Quality

Pg = Petagram
1 Pg = 1,000,000,000 metric tons

Atmosphere cube



Human activities have changed the way that carbon is distributed in Earth's atmosphere, lithosphere, hydrosphere, and biosphere.

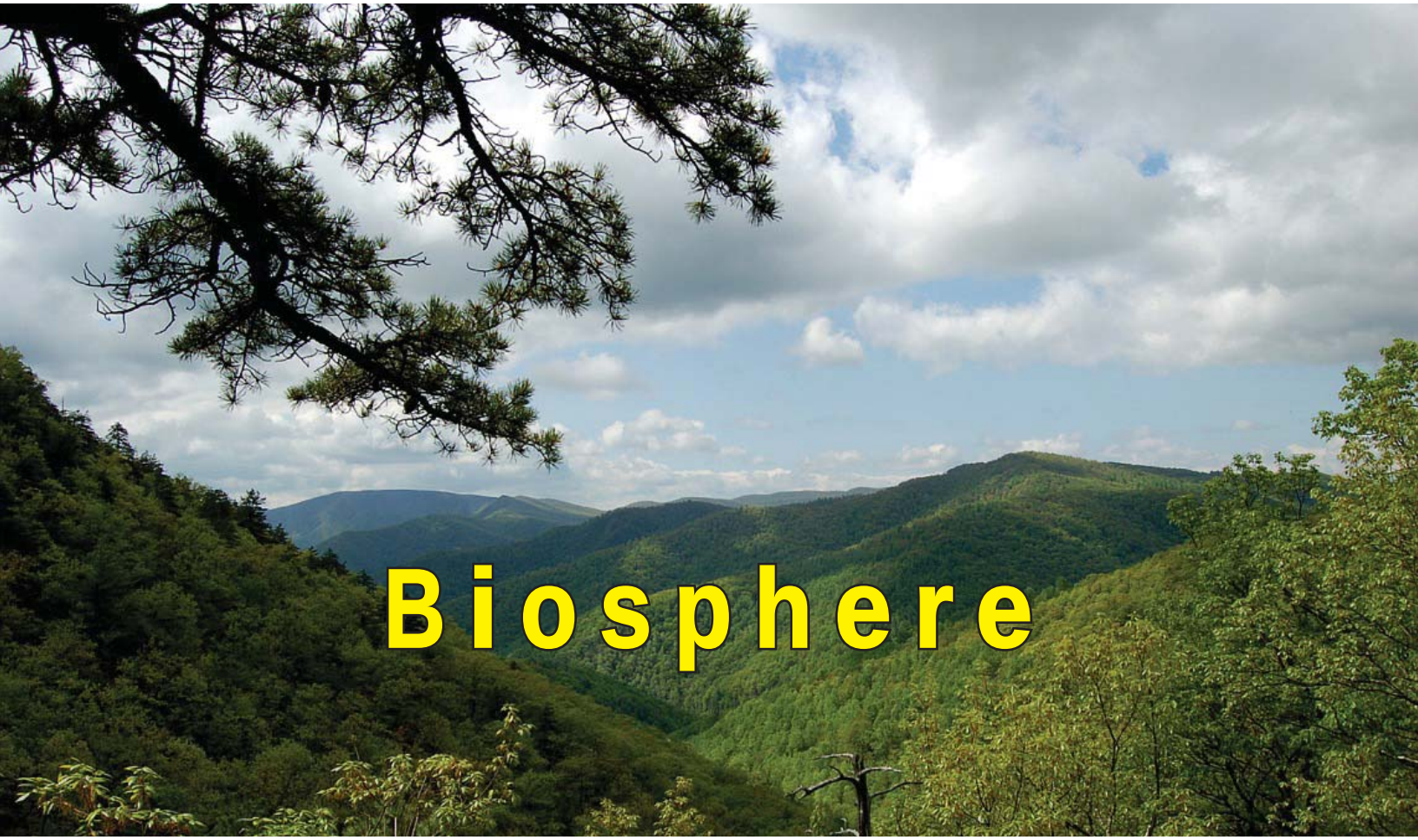
Biosphere cube

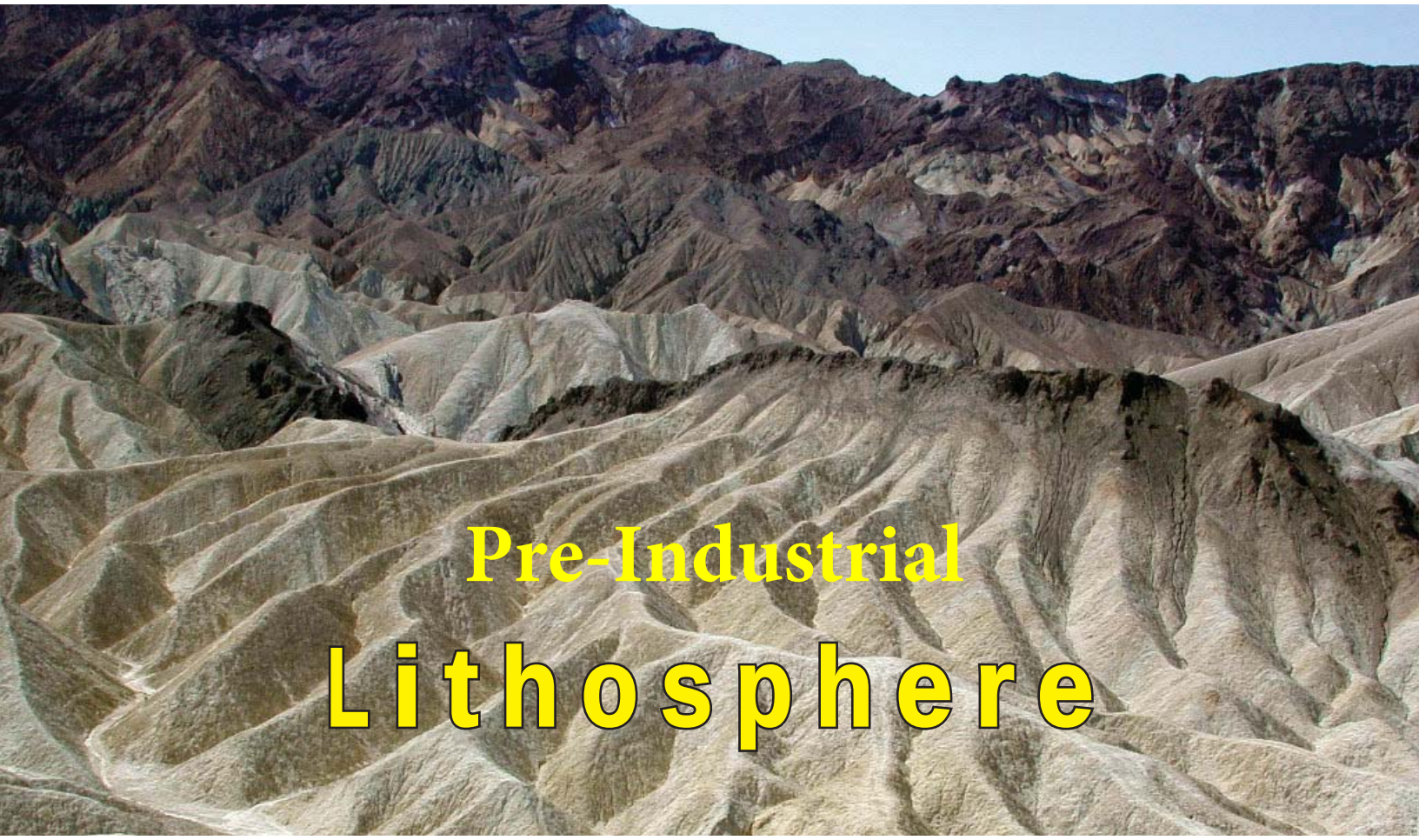
Hydrosphere cube

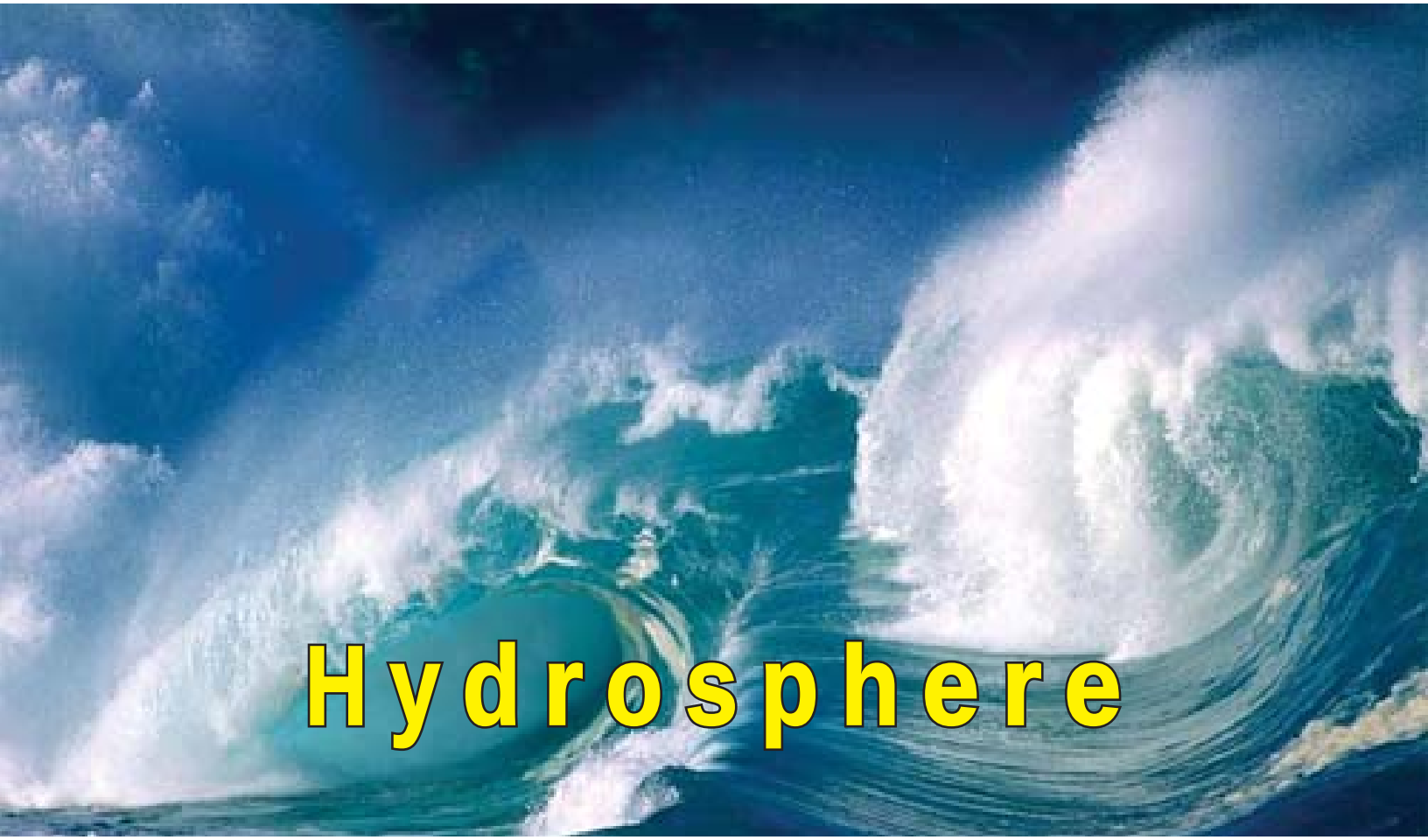
Human activities have changed the way that carbon is distributed in Earth's atmosphere, lithosphere, hydrosphere, and biosphere.

Pre-industrial Lithosphere cube 1

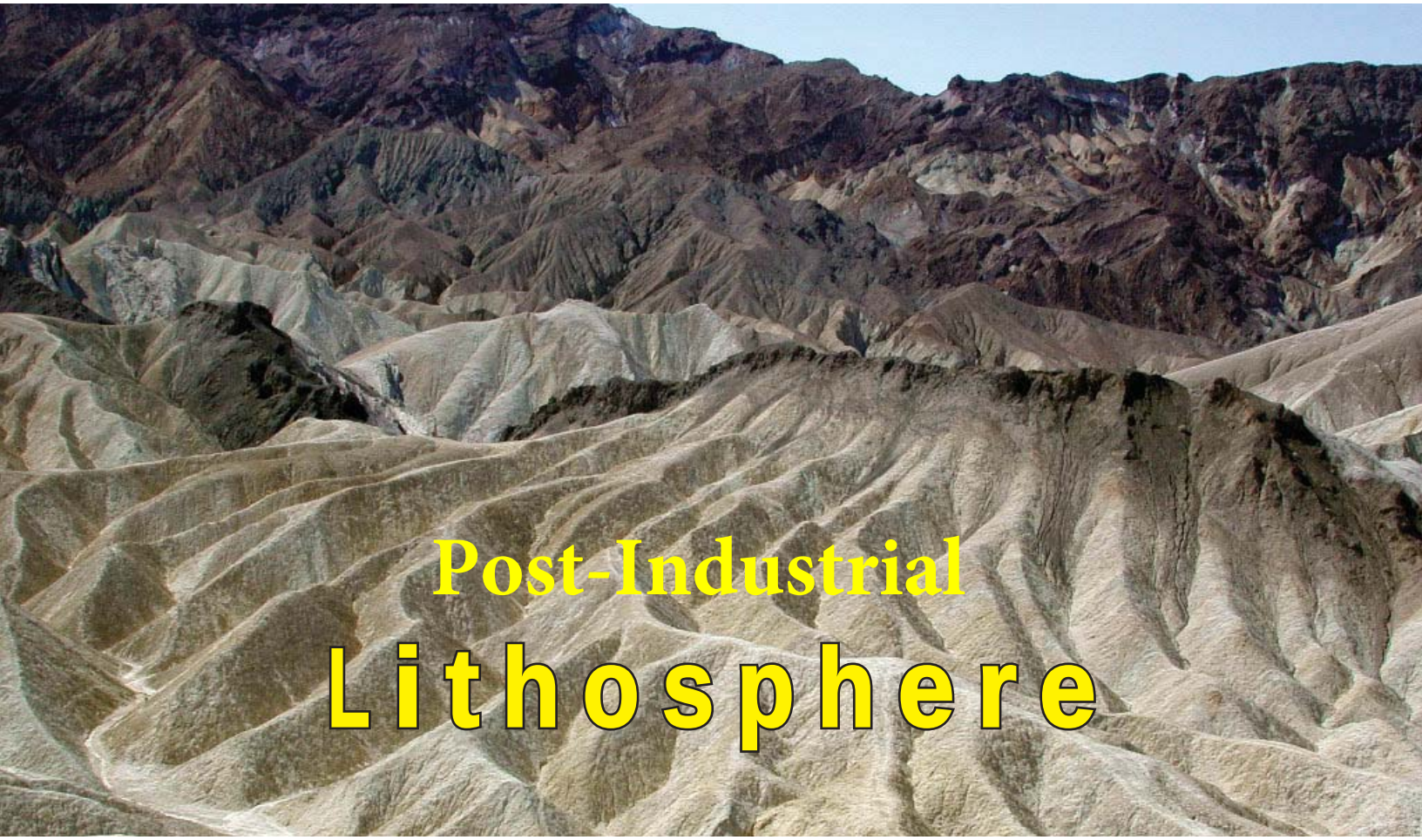
Post-industrial Lithosphere cube 2


Biosphere


Pre-Industrial
Lithosphere


Hydrosphere


Atmosphere


Post-Industrial
Lithosphere


Atmosphere