

Earth Systems & Feedback Loops

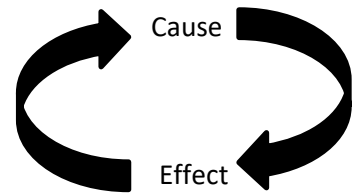
Earth is a dynamic planet. Interactions of the geosphere, atmosphere, exosphere, and hydrosphere can be explained, modeled, and predicted through the use of **feedback loops**.

Purpose – to learn what a feedback loop is and how they apply to Earth’s systems.

Activity 1 – Feedback Loop

When a system in nature is balanced, it is called equilibrium. Equilibrium can be defined as a system in balance, when the inputs and outputs do not vary over time. If a system is in a state of equilibrium it is stable, but not unchanging. When nature is left to itself, it often reaches equilibrium, at least until the next volcanic eruption or ice age arrives. These events are **actions or causes**. Humans also create the “action” when they alter the natural system. The action is often followed by an **effect**. Basically, a feedback loop is a cause and result loop in a system.

Think of what would happen in the following scenario. You are cold and want to warm up, so you put an electric blanket and turn it on. What effect do you think this would have on you? Scientists call the reaction “feedback” and it can be positive or negative.



Let’s say that the electric blanket does not work (figuring out why uses the scientific method). This would be a negative feedback loop because it reduces the chance that you will use that electric blanket again. If the electric blanket works and you warm up, this is a positive feedback loop. Not because you warmed up (although that is what you wanted) it means that there is an increased likelihood that the “action” (using the electric blanket) will occur again.

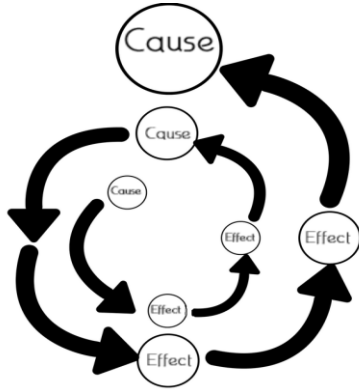
Analysis Questions

1. What does equilibrium mean?
2. Explain what it means when a system is in equilibrium.
3. What is feedback?
4. What is negative feedback?
5. What is positive feedback?

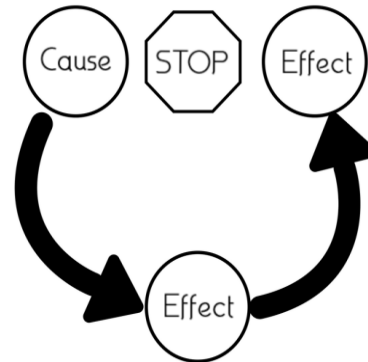
Activity 2 – Positive and Negative Feedback Loops

Directions - For each of these examples, explore the cause and effect relationships. Then determine if a positive or a negative feedback loop is demonstrated, then write a few sentences to explain your reasoning.

Example of positive feedback loop.



Example of negative feedback loop.



Albedo Effect

Albedo is the reflection of the sun's light from a surface. Various surfaces reflect and absorb light in different ways. Ice reflects about 85% of light, having a high albedo, while a dense forest reflects only about 15% of light, having a low albedo. Water and soil also have low albedos, absorbing more light energy than they reflect. When warming occurs, ice melts. Meaning that albedo levels decrease and more heat from light is absorbed on Earth.

1. What type of feedback loop does the albedo effect demonstrate?
2. Explain your reasoning.

Gas Release from Melting Ice

As temperature warms, ice and the frozen soil (permafrost) melts. As ice and the frozen soil melt, gases, like methane and carbon dioxide that were trapped inside of the ice and soil are released. These gases are greenhouse gases and will accumulate in the atmosphere, increasing the greenhouse effect.

3. What type of feedback loop does the gas release from melting ice demonstrate?
4. Explain your reasoning.

Tree's Growth

As temperatures warm, plants tend to perform photosynthesis at a higher rate, meaning that their uptake of carbon dioxide will increase. This carbon dioxide is absorbed from the atmosphere, causing there to be less greenhouse gases in the atmosphere and a decrease in the greenhouse effect.

5. What type of feedback loop does the tree's growth demonstrate?
6. Explain your reasoning.

Cloud Cover

As warming occurs, evaporation of surface water and moisture from the soil increases. This will increase cloud cover. Clouds have a high albedo, causing less sunlight to be absorbed by Earth's surface.

7. What type of feedback loop does the cloud cover demonstrate?
8. Explain your reasoning.