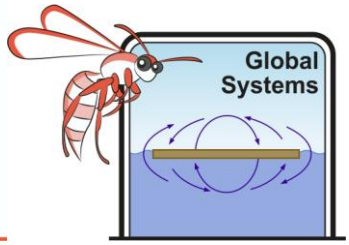


Permafrost Feedback Loops - Student Activity

Feedback loops

To be stable, systems need to be self-regulating. Feedback loops permit systems to modify their response to change (forcing factors) to return to stable conditions. Human beings depend on feedback loops to keep our bodies balanced and healthy.

A negative feedback loop reduces the effect of change and helps maintain balance within our bodies.

A positive feedback loop increases the effect of the change and the system becomes unstable.

Feedback scenarios

Which of the following feedback loops are ***positive*** and which are ***negative***? Explain your answers.

1. A student eats a whole bag of salty chips and becomes thirsty as a result. They drink two glasses of water and no longer feel thirsty.

_____

2. Beer contains chemicals (diuretics) that make people thirsty. At home a teacher drinks two glasses of beer because they feel hot and thirsty. After twenty minutes they feel even thirstier and drink more beer.

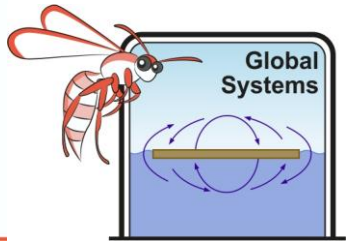
_____

3. Late for class, students run the last 200m very quickly. They arrive outside the door gasping for breath, however four deep breaths bring them back to normal and they calmly walk through the door.

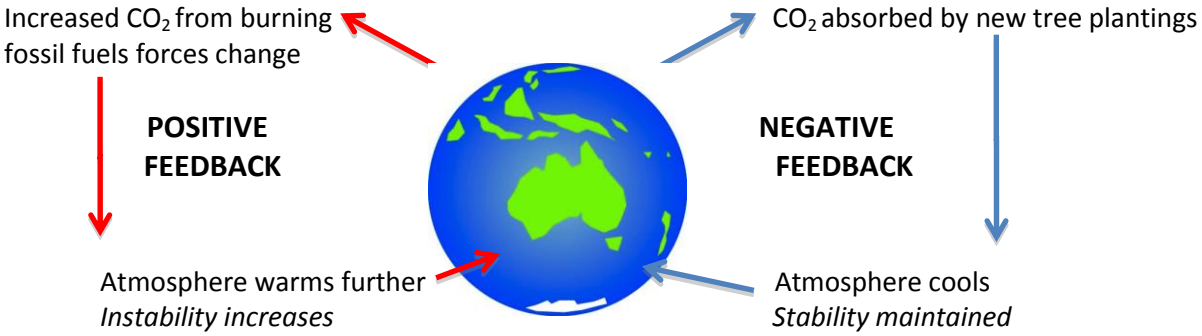
_____

Climate feedback loops

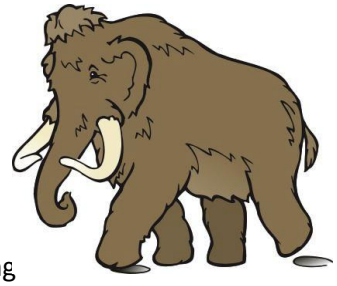
Climate stability is the result of many systems working together. Feedback loops can maintain a stable climate system. There should be balance between the rain that falls from the sky (condensation) and the evaporation from the ocean that returns to the sky (atmosphere). Human generated changes can produce ***forcing factors*** that can destroy balance. Burning fossil fuels pumps unusually high amounts of carbon dioxide into the atmosphere. The effect of this forcing factor can be negated however.



Permafrost Feedback Loops - Student Activity



The effect of climate change warming on permafrost

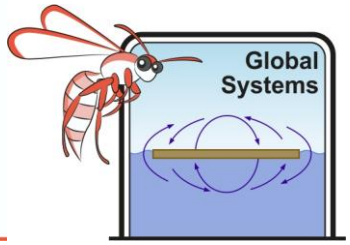


Permafrost is frozen soil, rock and organic materials. It occurs at high altitudes and high latitudes (near the poles). The ground must remain frozen for over two years. Most of our present permafrost has remained unmelted since the last Ice Age. Bacteria in the soil decompose organic matter producing methane and carbon dioxide as a by-product. These gasses are held within an ice matrix as clathrates. Permafrost acts as a long term carbon sink. The bodies of woolly mammoths have been found in perfect condition in permafrost in Siberia. Studies in Canada suggest that permafrost areas are decreasing. If our climate warms due to increasing levels of greenhouse gasses, more soil will defrost and these gasses will dissolve into water and diffuse into the atmosphere to join other greenhouse gasses.

Will this increase in aerosol gasses result in positive or negative feedback? _____

_____

Write a flow chart (loop) or draw a labelled diagram describing the sequence of events that may be precipitated when permafrost starts to melt. Name the sinks and releasing factors for methane.



Permafrost Feedback Loops - Student Activity

Methane has a relatively short residence in the atmosphere. It only remains for about 10 years before it breaks down to form carbon dioxide and water. It is however twenty times more effective in heat retention than carbon dioxide.
Describe two forcing factors leading to global warming that occur when permafrost melts and methane levels in the atmosphere rise.

_____

_____

Individual carbon dioxide molecules only remain in the atmosphere a few days before they dissolve into the ocean. To maintain equivalence of partial pressure however, for every molecule that is absorbed by the ocean, it releases one into the atmosphere to maintain balance.

If melting permafrost releases 12 molecules of carbon dioxide into the atmosphere:

How many molecules will be almost immediately absorbed into the sea? _____

After a short time how many molecules will remain in the sea? _____

What effect will these molecules of carbon dioxide have on the pH/acidity or alkalinity of the sea?

_____

What effect might this change have on sea organisms which have carbonate shells or skeletons?

_____

Interesting fact Isotope analysis suggests one forcing factor causing the greatest mass extinction of life on earth was climate warming causing the release of methane from permafrost areas and ocean depths.