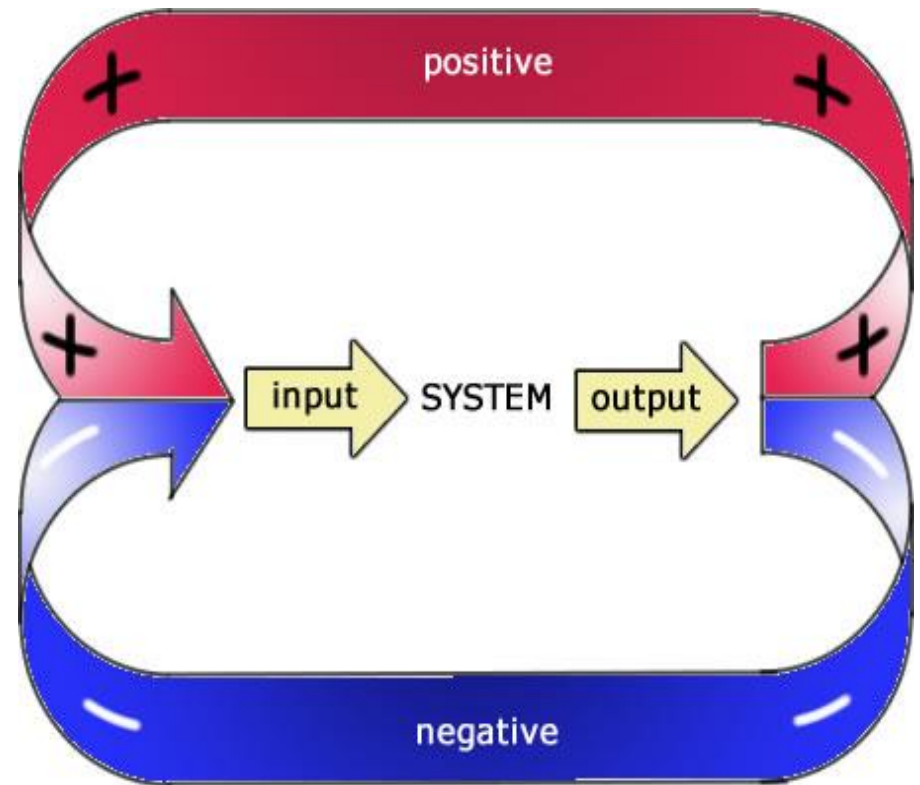


Climate Feedback Loops

+ What are climate feedback loops?

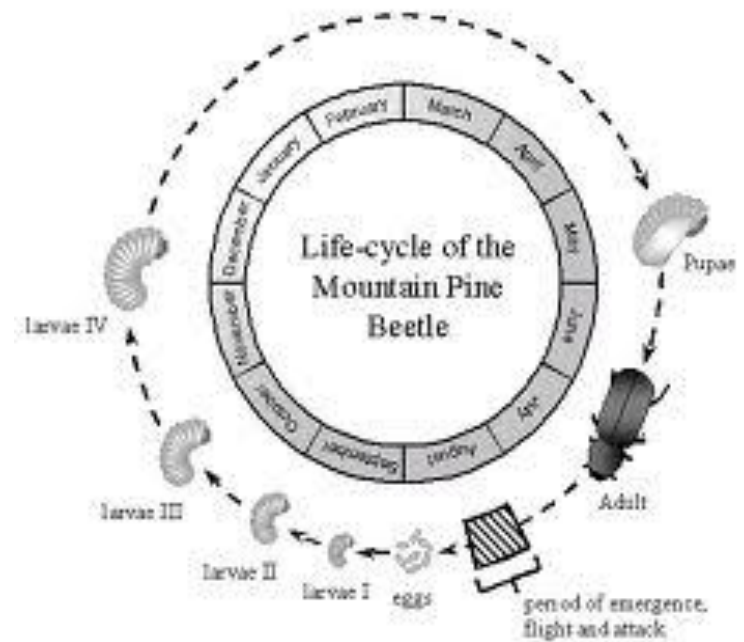
- The earth's climate contains many feedback cycles. Feedback loops (or cycles) can be described as a circuit-like system, where an initial disturbance initiates change in the output of a system. This output influences subsequent occurrences of the initial disturbance.



+ Example:

Carbon Feedback Loop: Humans have impacted the carbon cycle by:

- Burning large amounts of fossil fuels and emitting tons more carbon dioxide into the atmosphere are increasing the overall temperature and concentration of CO₂ on the planet.
- Deforestation: forests and oceans are two large carbon sinks, and when humans cut down and burn trees, it reduces the amount of carbon that can be absorbed.



Mountain Pine Beetles affecting the carbon cycle:

Warming temperatures have allowed Mountain Pine Beetles to go through their life-cycle more than once a year because temperatures have not been cold enough to kill them. In turn, the beetles kill many trees, many in the Colorado Rockies. When trees die they are no longer able to absorb carbon and instead become a forest-fire fuel source adding to the amount of carbon in the atmosphere.

Tsai, Catherine. *Pine Beetles Turn Forests From Carbon Sinks to Sources*. National Geographic. April, 2004.

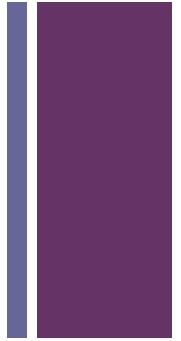


Positive Feedback Loops

- In a positive feedback loop, the output of the system serves to reinforce or amplify the initial disturbance. In this way, A produces B which creates more of A.

Negative Feedback Loops

In a negative feedback loop, the output of the system acts to restrict the effects of the initial disturbance. In this case, A produces B which reduces the amount of A.



Positive and negative refer to the direction of change, not necessarily the desirability of their effects

Generally, positive forcings warm the earth, and negative forcings cool it.



How Climate Feedbacks Worsen Global Warming

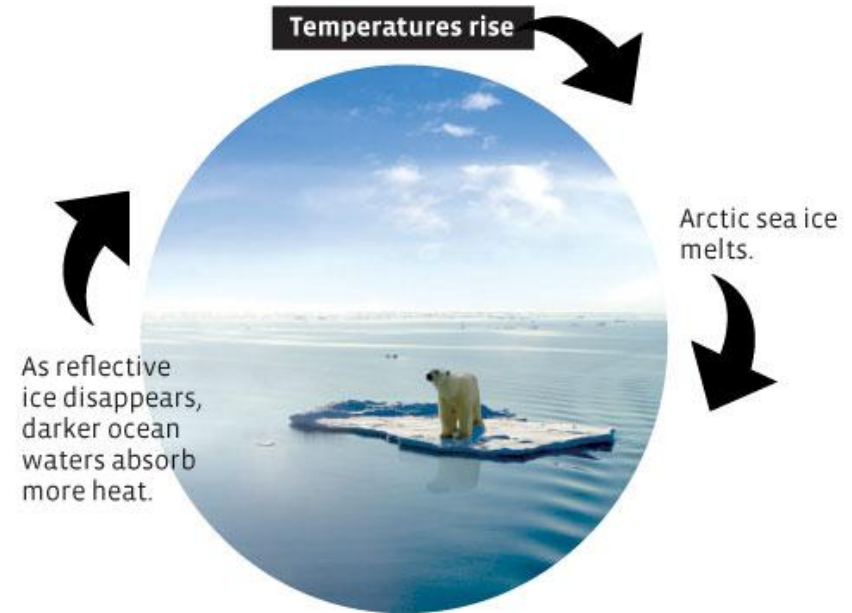
The video player displays a man in a blue shirt and glasses speaking. A 'bigpicturetv' logo is visible on his shirt. In the top right corner of the video frame, there is a 'Related' link with a double-left arrow icon. The video player interface includes a progress bar at the bottom left showing '01:19/05:04', and a control bar at the bottom right with icons for Aol On, volume, 320p resolution, and social media sharing options.



Climate Feedbacks in High Mountain Ecosystems:

- Snow/Ice Albedo feedbacks:
- Rising temperatures melt snow and reduce surface reflectivity which in turn increases the absorption of solar radiation.
- This feedback mechanism increases the maximum temperatures.
- As global average temperatures rise, glaciers and Arctic sea ice are melting at increasing rates. This feedback loop is strongest at lower elevations early in the winter and at higher elevations later in the year.

VANISHING ARCTIC ICE



Albedo: “whiteness” or the ability of a surface to reflect sunlight back into the atmosphere. It is defined as the ratio of reflected radiation from the surface to incident radiation upon it.

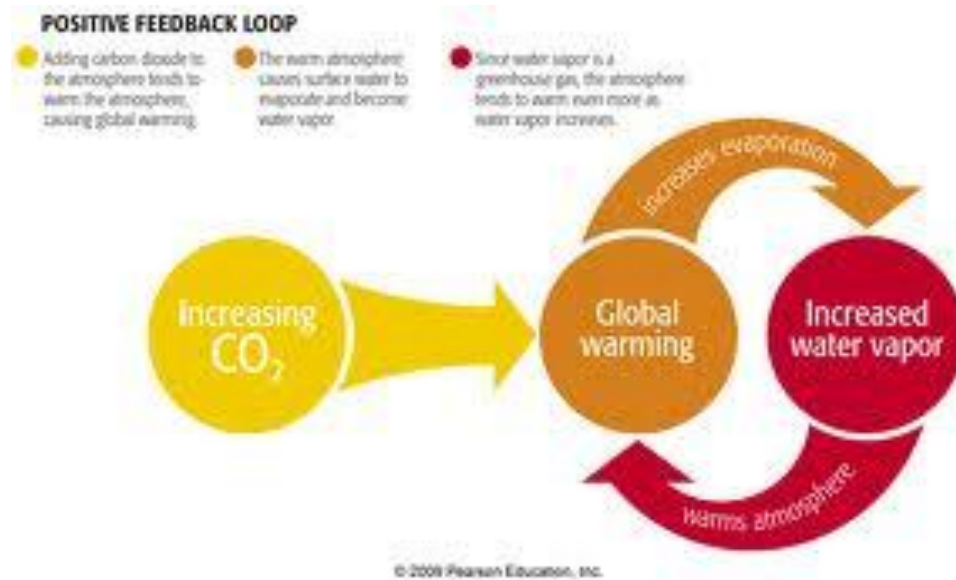
Imtiaz Rangwala and James Miller. *Climate change in mountains: a review of elevation-dependant warming and it's possible causes*. Springer Science + Business Media B.V. April 2011.



Water Vapor Feedback

- Water vapor feedback is the thermal consequence of changing atmospheric water vapor concentrations in response to some change in global temperature because water vapor is a greenhouse gas.¹
- The water vapor feedback acts to amplify other feedbacks in models, such as the cloud feedback and snow/ice feedback.²
- Higher temperatures allow air to hold more water vapor, which means that more thermal radiation is emitted by the atmosphere, some of which goes downward toward the surface.

- water vapor is much more prevalent (about 0.3% of atmospheric mass, compared to about 0.06% for CO₂), and so is a very important greenhouse gas



¹Nielsen-Gammon. Dispatch from AGU: How to Understand Water Vapor Feedback. 2012. Climate Abyss.

²ICPP, Working group I: The Scientific Basis. Water Vapor Feedback. 7.2.11. 2009.

³R.S. Lindzen, 1991. Quart. J. Roy. Met. Soc., 117, pp. 651-652. <http://www.realclimate.org/index.php/archives/2005/04/water-vapour-feedback-or-forcing/>