Definition of an Earth System Feedback

A feedback is a mechanism by which the end products of a process influence the ongoing operation of that process. A perturbation to the Earth system can lead to positive and/or negative feedbacks, as illustrated in the top panels. Negative feedbacks (–) help regulate the Earth system and maintain its equilibrium. For example, negative feedbacks between Earth's rock cycle (driven primarily by plate tectonics) and global biogeochemical cycles (especially for carbon, hydrogen, nitrogen, and sulfur) result in a relatively stable global climate over long timescales. In contrast, positive feedbacks (+) in the Earth system amplify the responses of processes, possibly leading to runaway behavior. For example, climate warming resulting from increasing atmospheric greenhouse gas concentrations causes sea ice to melt, decreasing surface albedo. The dark ocean waters absorb more solar radiation, resulting in more sea ice melting and enhanced ocean warming. Positive feedbacks that lead to runaway behavior are particularly important in the Earth system because they can drive the system past a **tipping point**, resulting in a dramatic, often irreversible shift in the system. One perturbation can also lead to multiple loops, some positive and some negative, as in the example at the bottom of a subset of feedbacks that influence global temperatures. The net effect of such networks of interrelated processes depends on the relative strength of the different feedback sub-loops, the timescales over which they operate, and how they interact. *Illustration by Rosalind Coggon*