



## **Some considerations of the concept of climate feedback**

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Discussions of the stability of the climate system and its sensitivity to external forcing in the current literature generally hinge on the concept of climate feedback. Borrowed from electrical circuit theory, the term feedback is used in multiple senses in the climate context, the two prototype usages being feedback in a stability sense (where a positive feedback gives a tendency towards asymptotic growth of internal perturbations) and feedback in a sensitivity sense (where a positive feedback gives an enhanced equilibrium response to an external forcing). It is widely assumed in the climate literature that these two senses of feedback are interchangeable, i.e., it is assumed that if an interaction between physical processes gives a feedback of a given sign in a stability sense, it gives a feedback of the same sign in a sensitivity sense. This assumption is examined using two simple climate models that embody dynamical interaction between zones and that allow analytical solution. In both cases it is shown that, in certain regions of parameter space, an interaction that provides a negative feedback in a stability sense can provide a positive feedback in a sensitivity sense. Thus, the common assumption regarding the interchangeability of feedback in these two senses, which derives from analyses using a monovariate model, has no general validity. It is also shown that, in a model more complex than a monovariate one, any inference about the sign of a stability feedback drawn from a consideration of initial tendencies can be misleading, since initial and asymptotic tendencies can be of opposite sign. These results point to the need for greater precision and explicitness in the definition and use of the term climate feedback. Definitions are proposed that, unlike those occurring in current glossaries, unambiguously distinguish between the two prototype concepts of climate feedback specified above.