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Using feedback analysis to uncover the physical origin of efficacy differences

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The climate sensitivity parameter has long been assumed to be constant. However, recent studies found that the climate sensitivity parameter varies, not only amongst models for the same forcing, but also within the same model where it may strongly depend on the strength and the type of the applied forcing. The so-called efficacy differences are essential to assess the relative importance of several contributing agents to a total climate impact.
Running equilibrium climate change simulation for various radiative forcing agents allows to quantify the efficacy differences, but the use of such information in assessment studies remains problematic as long as the underlying physical processes are insufficiently understood. By means of a feedback analysis, efficacy differences can be attributed to the responsible feedback processes.
Applying the „Partial Radiative Perturbation"-method to a set of CO_2 and non-CO_2 driven climate change simulation allows to identify those feedback processes which play the key role in controlling differences in efficacy. The water vapour, the cloud and the stratospheric temperature feedback vary the most under increasing CO_2 forcing. For differences in the efficacy between an ozone and a CO_2 driven simulation, the water vapour and the lapse rate feedback changes significantly, but their changes cancel each other. Hence, cloud and stratospheric temperature feedback are found to be responsible for a significantly lower efficacy in the ozone driven simulation.
Furthermore, in this talk we will point out some merits and shortcomings of the "Partial Radiative Perturbation"-method in determining global radiative feedbacks and we will outline an appropriate framework for the most auspicious application of this method. Statistical assessment problems arising for relatively small forcings, inherent non-linearities and inter-dependency of feedback mechanisms will all be addressed.