



The impact of the temperature-CO₂ decoupling on the state-dependency of paleo climate sensitivity during the late Pleistocene

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Climate change projections for the future are uncertain, also due to inter-model differences. The application of these models to paleo times, which can be constrained by reconstructions, is therefore essential, not only to gain a better understanding of past climate changes, but also for model validation purposes. In this respect both data- and model-based approaches have been used to generate time series of global temperature changes, ΔT_g . The ratio of ΔT_g over radiative forcing, ΔR , defines the specific equilibrium climate sensitivity S , and has been suggested to be state-dependent, potentially increasing towards warming climates, and therefore suggesting climate sensitivity for the future to be at the upper end of the range of published results (Köhler et al., 2015, 2017). Here we reanalyse existing time series of ΔT_g and ΔR for the last 800,000 years and show that this proposed state-dependency of S is only found if ΔT_g is based on data (reconstructions), and not if ΔT_g is based on models (simulations). We furthermore identify that in data-based reconstructions ΔT_g is decoupled from atmospheric CO₂ predominantly during times of decreasing obliquity (identical to periods of land-ice sheet growth and sea level fall), while in model simulations ΔT_g and CO₂ vary in phase throughout. This multi-millennial decoupling of CO₂ and temperature has been suggested to be partially caused by a sea level-induced surge in magma and CO₂ fluxes from oceanic hotspot volcanoes and mid ocean ridges (Hasenclever et al., 2017). The neglect of these feedbacks between the solid Earth and the climate system in recent Earth system models is partly responsible for the data/model misfit, and illustrates our current limitation in the model-based interpretation of the paleo records. Paleo-based estimates of S might be restricted to data without this ΔT_g -CO₂-decoupling leading to a 20% smaller quantification of S for interglacial conditions of the late Pleistocene.

References:

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