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State-dependent climate sensitivity of the last 5 million years

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Equilibrium temperature rise in response to increase in radiative forcing is called equilibrium climate sensitivity, an important quantity calculated by climate models to project future warming. For model validation comparisons with estimates based on paleo reconstructions are necessary. Here we use an energy balance model (Köhler et al., 2010) to estimate climate sensitivity using CO_2 proxy data together with model-based reconstruction of land ice (de Boer et al., 2014) over the last 5 million years. We find that equilibrium climate sensitivity containing the radiative forcing of CO_2 and land ice albedo depends on the background climate. This state-dependency is mainly contained in the non-linearity of the land-ice forcing. Results differ in detail if based on ice core CO_2 of the last 800,000 years covering mainly colder than present climates (von der Heydt et al., 2014) or on CO_2 proxies of the last 5 million years. Nevertheless, the climate sensitivity of the warm Pliocene, a paleo-analogy for a warmer future, is at least about a third higher than for preindustrial background climates.

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