



## The climate sensitivity parameter during the last 800 kyr - offsets due to transient effects and state dependency

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The climate sensitivity parameter  $S$  is defined as the equilibrium change in global annual mean surface temperature  $\Delta T$  per radiative forcing  $\Delta R$ ,  $S = \Delta T / \Delta R$ . We here combine a data set of radiative forcing  $\Delta R$  of greenhouse gases and albedo changes (Köhler et al., 2010) with an estimate of  $\Delta T$  based on the deconvolution of benthic  $\delta^{18}\text{O}$  into sealevel and temperature (Bintanja et al., 2005) for the last 800 kyr.

We show how  $S$  varies depending on the radiative forcing considered, e.g. if only  $\Delta R$  of  $\text{CO}_2$  or  $\Delta R$  of  $\text{CO}_2 + \text{CH}_4 + \text{N}_2\text{O}$  or additionally  $\Delta R$  of the albedo changes are taken into account. Furthermore we find, that for the LGM all calculated  $S$ , independent on the considered forcing  $\Delta R$  is about 10-15% smaller than if calculated for the whole 800 kyr time window. We propose that this difference between the rather stable climate of the LGM and the whole 800 kyr is caused by transient effects and the state dependency of  $S$ . We identify based on thresholds in temporal changes in  $\Delta T$  and  $\Delta R$  relatively stable climates and separate the transient effect from state dependency in  $S$ .

In a final application it is shown how the state dependency of  $S$  and assumptions on various slow and fast feedbacks are important for the functional relationship between  $\Delta T$  and  $\text{CO}_2$  for the range in  $\text{CO}_2$  observed in the past 800 kyr and proposed in the future ( $2 \times \text{CO}_2$ ).

### References

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