



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

P. Köhler (1), R.S.W. van de Wal (2), H.A. Dijkstra (2), and E.J. Rohling (3)

(1) Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven, Germany (peter.koehler@awi.de), (2) Institute for Marine and Atmospheric research Utrecht (IMAU), Utrecht University, Utrecht, The Netherlands, (3) School of Ocean and Earth Science, University of Southampton, National Oceanography Centre, Southampton, U.K.

The climate sensitivity parameter S is defined as the equilibrium change in global annual mean surface temperature ΔT per radiative forcing ΔR , $S = \Delta T / \Delta R$. We here combine a data set of radiative forcing ΔR of greenhouse gases and albedo changes (Köhler et al., 2010) with an estimate of ΔT 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 ΔR of CO_2 or ΔR of $\text{CO}_2 + \text{CH}_4 + \text{N}_2\text{O}$ or additionally ΔR of the albedo changes are taken into account. Furthermore we find, that for the LGM all calculated S , independent on the considered forcing ΔR 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 ΔT and ΔR 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 ΔT and CO_2 for the range in CO_2 observed in the past 800 kyr and proposed in the future ($2 \times \text{CO}_2$).

References

Köhler, P., Bintanja, R., Fischer, H., Joos, F., Knutti, R., Lohmann, G., Masson-Delmotte, V. (2010) What caused Earth's temperature variations during the last 800,000 years? Data-based evidences on radiative forcing and constraints on climate sensitivity. *Quaternary Science Reviews* 29, 129–145, doi: 10.1016/j.quascirev.2009.09.026.

Bintanja, R., van de Wal, R., Oerlemans, J. (2005) Modelled atmospheric temperatures and global sea levels over the past million years. *Nature* 437, 125–128, doi: 10.1038/nature03975.