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Implications of high amplitude atmospheric CO2 fluctuations on past millennium climate change

Thomas van Hoof (1), Lenny Kouwenberg (2), Friederike Wagner-Cremer (3), and Henk Visscher (3)

(1) TNO/Geological Survey of the Netherlands, Geo-energy and Geo-informatics, Utrecht, Netherlands (tom.vanhoof@tno.nl), (2) Department of Integrative Biology, University of California, Berkeley, USA , (3) Palaeoecology, Institute of Environmental Biology and Laboratory of Palaeobotany and Palynology, Utrecht University, Utrecht, Netherlands

Stomatal frequency analysis of leaves of land plants preserved in peat and lake deposits can provide a proxy record of pre-industrial atmospheric CO2 concentration complementary to measurements in Antarctic ice cores. Stomatal frequency based CO2 trends from the USA and NW European support the presence of significant CO2 variability during the first half of the last millennium (Kouwenberg et al., 2005; Wagner et al., 2004; van Hoof et al., 2008). The timing of the most significant perturbation in the stomata records (1200 AD) is in agreement with an observed CO2 fluctuation in the D47 Antarctic ice-core record (Barnola et al., 1995; van Hoof et al., 2005). The amplitude of the stomatal frequency based CO2 changes (> 34ppmv) exceeds the maximum amplitude of CO2 variability in the D47 ice core (< 10 ppmv). A modelling experiment taking into account firn-densification based smoothing processes in the D47 ice core proved, however, that the amplitude difference between the stomata record and the D47 ice-core can be explained by natural smoothing processes in the ice (van Hoof et al., 2005). This observation gives credence to the existence of high-amplitude CO2 fluctuations during the last millennium and suggests that high resolution ice core CO2 records should be regarded as a smoothed representation of the atmospheric CO2 signal. In the present study, potential marine and terrestrial sources and sinks associated with the observed atmospheric CO2 perturbation will be discussed. The magnitude of the observed CO2 variability implies that inferred changes in CO2 radiative forcing are of a similar magnitude as variations ascribed to other forcing mechanisms (e.g. solar forcing and volcanism), therefore challenging the IPCC concept of CO2 as an insignificant preindustrial climate forcing factor.

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