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The role of atmospheric CO_2 variability on the Holocene climate of the Northern Hemisphere – evidence from stomatal frequency analysis of Iberian oak leaves

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Stomatal frequency analysis of Quercus robur leaf remains from the northern part of the Iberian Peninsula allows the reconstruction of millennial-scale atmospheric CO_2 variability during the last 10000 years. Between ∼7000 cal yrs BP and ∼4000 cal yrs BP reconstructed perturbations show a maximum positive deviation of 10.4 ppmv from the average Holocene CO_2 level. Minimum deviations of 9 ppmv and 5.5 ppmv are recorded at 8570 cal yrs BP and at 2830 cal yrs BP, respectively. A return to mean CO_2 values is observed around 1230 cal yrs BP. The detected CO_2 trends correlate with regional marine and continental temperature reconstructions and support a temporal link between CO_2 dynamics and major Holocene climatic events on the Northern Hemisphere. Calculation of the radiative forcing of the CO_2 perturbations indicates that they amplified Northern-Hemisphere air-temperature anomalies with up to 0.19 ºC. This amplification corresponds to 20% of the 65ºN annual insolation decrease and 10% of the Holocene mean temperature anomalies on the Northern Hemisphere. Therefore it is concluded that atmospheric CO_2 had an active role as a climate-forcing factor during the Holocene.