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Ecosystem effects of CO_2 concentration: evidence from past climates

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Abstract. Atmospheric CO_2 concentration has varied from minima of 170–200 ppm in glacials to maxima of 280–300 ppm in the recent interglacials. Photosynthesis by C_3 plants is highly sensitive to CO_2 concentration variations in this range. Physiological consequences of the CO_2 changes should therefore be discernible in palaeodata. Several lines of evidence support this expectation. Reduced terrestrial carbon storage during glacials, indicated by the shift in stable isotope composition of dissolved inorganic carbon in the ocean, cannot be explained by climate or sea-level changes. It is however consistent with predictions of current process-based models that propagate known physiological CO_2 effects into net primary production at the ecosystem scale. Restricted forest cover during glacial periods, indicated by pollen assemblages dominated by non-arboreal taxa, cannot be reproduced accurately by palaeoclimate models unless CO_2 effects on C_3-C_4 plant competition are also modelled. It follows that methods to reconstruct climate from palaeodata should account for CO_2 concentration changes. When they do so, they yield results more consistent with palaeoclimate models. In conclusion, the palaeorecord of the Late Quaternary, interpreted with the help of climate and ecosystem models, provides evidence that CO_2 effects at the ecosystem scale are neither trivial nor transient.

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