Climate of the Past
An Interactive Open Access Journal of the European Geosciences Union

Clim. Past, 2, 205-220, 2006
www.clim-past.net/2/205/2006/

Dynamics of the terrestrial biosphere, climate and atmospheric CO_2 concentration during interglacials: a comparison between Eemian and Holocene

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Abstract. A complex earth system model (atmosphere and ocean general circulation models, ocean biogeochemistry and terrestrial biosphere) was used to perform transient simulations of two interglacial sections (Eemian, 128–113 ky B.P., and Holocene, 9 ky B.P.–present). The changes in terrestrial carbon storage during these interglacials were studied with respect to changes in the earth's orbit. The effects of different climate factors on changes in carbon storage were studied in offline experiments in which the vegetation model was forced only with temperature, hydrological parameters, radiation, or CO_2 concentration from the transient runs.

The largest anomalies in terrestrial carbon storage were caused by temperature changes. However, the increase in storage due to forest expansion and increased photosynthesis in the high latitudes was nearly balanced by the decrease due to increased respiration. Large positive effects on carbon storage were caused by an enhanced monsoon circulation in the subtropics between 128 and 121 ky B.P. and between 9 and 6 ky B.P., and by increases in incoming radiation during summer for 45° to 70° N compared to a control simulation with present-day insolation.

Compared to this control simulation, the net effect of these changes was a positive carbon storage anomaly in the terrestrial biosphere of about 200 Pg C for 125 ky B.P. and 7 ky B.P., and a negative anomaly around 150 Pg C for 116 ky B.P. Although the net increases for Eemian and Holocene were rather similar, the magnitudes of the processes causing these effects were different. The decrease in terrestrial carbon storage during the experiments was the main driver of an increase in atmospheric CO_2 concentration during both the Eemian and the Holocene.

Final Revised Paper (PDF, 4171 KB) | Discussion Paper (CPD)

Citation: Schurgers, G., Mikolajewicz, U., Gröger, M., Maier-Reimer, E., Vizcaíno, M., and Winguth, A.: Dynamics of the terrestrial biosphere, climate

and atmospheric CO_2 concentration during interglacials: a comparison between Eemian and Holocene, Clim. Past, 2, 205-220, 2006. Bibtex EndNote Reference Manager