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Climate of the Past Discussions

Interactive comment on "Changes in terrestrial carbon storage during interglacials: a comparison between Eemian and Holocene" *by* G. Schurgers et al.

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In a new version of the manuscript, the feedbacks between terrestrial carbon, atmospheric CO2 and climate get more attention. Additional paragraphs were included in the "Conclusions and discussion":

From a previous study with the same earth system model (Mikolajewicz et al., accepted), the distribution of CO2 emitted over atmosphere, land and ocean equilibrated at approximately 10%, 18% and 72%, using a scenario with relatively low emissions. In the insolation experiments presented here, the ratio between marine and atmospheric storage is higher than for this equilibrium state, especially for the beginning of both experiments, when marine storage is lower than the control run. This deviation from

the equilibrium state could be caused by the gradual CO2 change, which inhibits especially the ocean from reaching equilibrium, and by changes in climate, which could cause that the ocean is not just playing a passive role in the interglacial carbon cycle.

The effect of the increasing atmospheric CO2 concentration on climate is expected to be minor: the increase of 20 ppm (Eemian) and 10 ppm (Holocene) would lead to an increase of about 0.1 to 0.2 K, assuming the system would be able to equilibrate. The temperature sensitivity of the earth system model to a doubling of the CO2 concentration is 2.3 K after equilibration (Mikolajewicz et al., accepted).

The changes in CO2 concentration are both for terrestrial carbon storage and for global climate minor effects. Despite the rising concentration, both global temperature (fig. 1a) and terrestrial carbon storage (fig. 3b) decrease during the interglacials. Terrestrial carbon storage was a main driver of the changes in atmospheric CO2. This indicates that the negative feedback between terrestrial carbon storage and CO2 concentration is rather weak, as well as the feedback between CO2 concentration and climate change. The changes in the orbital forcing are of much larger importance for both carbon storage and climate.

Besides that, one paragraph was changed in order to give a clearer comparison between simulated and measured atmospheric CO2 concentration for the interglacials:

In this study we observed the opposite effect: for the last 8000 years it showed a decrease in terrestrial carbon storage of 200 Pg C. This is in agreement with the estimate by Indermühle et al. (1999) of 260 Pg C for 7 - 1 ky B.P. A decrease was simulated by Brovkin et al. (2002) as well, with a magnitude of 90 Pg C for 8 ky B.P. - present. The simulated atmospheric CO2 concentration showed similar trends for the Eemian and the Holocene. The amplitude of CO2 changes for the Holocene is too small compared to ice core measurements (Indermühle et al., 1999). For the Eemian, the comparison between model and data is harder, because there are less data points, and there is no clear trend in the data. Differences between the terrestrial carbon and atmospheric

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CO2 estimates, as well as uncertainties about the terrestrial biosphere being a source or a sink of carbon during the last 8000 years, could be due to uncertainties in the temperature effect. The simulations showed that temperature changes have two opposing effects, of which the net outcome might be climate- and model-dependent. A second important factor for the difference between model results and observations is related to the initial conditions. The steady-state present-day circulation that was used here to start the simulations from does not reflect the actual transition from the glacial that preceded the interglacials. Besides that, Kaplan et al. (2002) state that they might have underestimated the carbon loss due to changes in the monsoon. In our simulations, hydrological changes were responsible for a decrease of 100 Pg C during the last 8000 years.

Interactive comment on Clim. Past Discuss., 2, 449, 2006.