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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.

Anonymous Referee #1

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General comments

This manuscript presents a groundbreaking study of long-term changes in the coupled earth system with full-complexity models of the atmosphere, oceans, and terrestrial biosphere. The authors tackle the intriguing problem of explaining climate-carbon cycle dynamics during interglacials, specifically during the Holocene and Eemian. The focus of the study is to explore the role of the terrestrial biosphere in controlling atmospheric CO2 concentrations during interglacials. With this goal, the authors perform a variety of experiments with the fully coupled model, and with the dynamic global vegetation model (DGVM) alone in an offline mode to test model sensitivities and various

hypotheses about environmental drivers.

The manuscript is well structured and easy to read. It is refreshingly concise and conveys the experimental setup and results through clear figures and tables. However, the text has many incidences of improper or awkward English usage, grammar and punctuation. As such, the manuscript would benefit from a light editing job by a native English speaker or technical editor.

The scientific content of this study is generally sound, though limitations in the terrestrial vegetation model (LPJ DGVM) and an incomplete discussion of the ocean carbon dynamics and modeled ocean responses to changing forcing should prevent the authors from putting much confidence in their conclusion that the terrestrial biosphere was responsible for the atmospheric CO2 increase during the latter part of the interglacial periods.

LPJ, which was designed largely for studying interannual to century-scale dynamics of the terrestrial carbon cycle, has no provision to simulate the long-term accumulation of soil organic matter. Indeed, the longest residence time of C in LPJ is 1000 years, and the fraction of C added to this slow pool is fixed for all climate conditions, soil types, and PFTs. Acknowledging this point, the authors make the short comment in their conclusions that their DGVM lacks a model for peatlands and the general accumulation of organic matter in anoxic soils. This is potentially a very important omission, and some more discussions from the authors on this point would be illustrative. Recent synthesis of field measurements in Siberian peatlands alone, indicates that 70 Pg of C could have been sequestered over the past 9 ka (1), and global estimates reach ˜300 Pg C (2). Such effects would have a major influence on the manuscript's conclusions, given that the coupled model simulates changes in terrestrial C storage of a similar magnitude. Some very simple peat accumulation modeling, even if included in an offline sensitivity test, would greatly strengthen the manuscript's credibility, though it could force a revision of the conclusions.

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While the model has a full representation of ocean physics and the ocean carbon cycle, I find discussion of processes on ocean carbon dynamics lacking. Recent studies have demonstrated, e.g., the potential importance of sea ice cover, carbonate compensation, or coral reef growth in influencing Holocene CO2 concentrations. While I realize the focus of the manuscript is on the terrestrial biosphere, without a presentation and/or discussion of these ocean processes, conclusions on the causes of atmospheric CO2 dynamics would also be are difficult to draw. If model results are available from these simulations to comment on ocean C processes, brief presentation, e.g, in a figure would be helpful. If they were not available, some literature review of model sensitivities and magnitude of effects would be necessary to make the current manuscript more convincing.

Minor point

Figure 3: Can you not plot corresponding CO2 concentration data for the Eemian? There are at least 7-8 points available from Vostok, and perhaps something available from EPICA Dome C?

References

1. L.C. Smith et al. Science, 303, 353-356 2. K. Gajewski et al. Global Biogeochemical Cycles, 15, 297-310

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