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Interactive comment on "Simulation of climate, ice sheets and CO_2 evolution during the last four glacial cycles with an Earth system model of intermediate complexity" *by* Andrei Ganopolski and Victor Brovkin

Anonymous Referee #1

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Ganopolski and Brovkin simulate four Glacial/interglacial (G/IG) cycles with the model of intermediate complexity CLIMBER2 in both a fully interactive and 1 way coupled mode. In both set ups, the model is able to reproduce the major features of G/IG cycles: i.e. changes in sea-level, ice-sheet extent (and volume), atmospheric CO2... It is an interesting study, certainly worth publishing in Climate of the Past. My main comment would be that I don't find the goals or conclusions of the study very clear. The manuscript tries to tackle various aspects of G/IG cycles but without going deeply in any of them. The authors are rightly very careful in not over-interpreting or making hasted conclusions from their results because the model used is quite simple. But

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maybe the study would gain in visibility by focusing on fewer points and putting them in a broader context. Please find additional comments below.

1) The first part of the introduction suggests that the radiative role of CO2 in driving 100kyrs G/IG cycles is controversial. To explore this, a simulation with constant pCO2 (240ppm) is performed. It leads to G/IG variations with ∼50% full G/IG amplitude and with dominant periodicity of 40ka. To me, this would tend to highlight the dominant role of CO2 in driving 100ka cycles, but this result or its implications are not really discussed.

2) CO2 changes:

The study simulates full G/IG changes in pCO2 due to a combination of processes and in global agreement with previous studies. However, due to the relative simplicity of the model and its configuration (zonally-averaged basin), I would think that the impact on pCO2 of oceanic circulation changes, sea-ice and wind related changes are underestimated, while iron fertilization changes are overestimated. In addition, I am a bit surprised not to see any mention of the impact of changes in the carbonate system (e.g. shallow water carbonate deposition). A few studies (see A. Ridgwell or F. Joos studies) have shown that this has a significant impact on pCO2 particularly at the end of the deglaciations (early interglacial) and thus also glacial inceptions.

The authors highlight the impact of deglacial AMOC changes on the shape of the pCO2 trajectory at the end of the deglacial phase. This is an interesting aspect but: i) Its reasons are not discussed in details ii) Can we really believe it given that the shape and timing of the deglacial CO2 changes are not represented correctly and some processes are likely missing or misrepresented (e.g. shallow water carbonate deposition, oceanic circulation changes).

3) Minor Changes in weathering and its impact on pCO2 are not very clear. I realize it is mentioned in Brovkin et al., 2012, but maybe a brief description might be useful.

Figure legends: Please make sure all appropriate references for the proxy are included in figure legends. For example Antarctic dust in Figure 2, Figure 4c... Proxy for atm. d13CO2 could be included in Figure 4b, even if they only cover part of the last G/IG cycle. Figure 8a: purple line.

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