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Interactive Comment

Interactive comment on "Carbon cycle dynamics during recent interglacials" *by* T. Kleinen et al.

Anonymous Referee #1

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The goal of the study is to understand the atmospheric CO2 and d13CO2 evolution during three interglacials: the Holocene, the Eemian and MIS11 using the CLIMBER2 model. The study focuses on the role of shallow water carbonate sedimentation and peat accumulation. For that purpose CLIMBER2 is coupled to the land model LPJ and shallow water carbonate sedimentation is estimated from a simple formulation.

The roles of CaCO3 sedimentation and changes in land carbon on atmospheric CO2 and d13CO2 have been previously studied for the Holocene (including by the authors in Kleinen et al. 2010). However, changes in atmospheric CO2 and d13CO2 during the Eemian and MIS11 have received little (if any) attention. It is an interesting paper, worth publishing in Climate of the Past. Please find a few comments below.

1) Since it has been more studied, estimates of CaCO3 sedimentation and peat accumulation as well as pCO2 and d13CO2 measurements are more accurate for the

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Holocene. The Holocene simulation could work as a validation of the modelling approach used here. More information could thus be taken out of that simulation to inform on the other 2.

The simulated changes in peat accumulation for the Holocene are in line with previous studies (e.g. Yu et al. 2010, Spahni et al. 2013). But I wonder what are the uncertainties associated with the peat accumulation estimates and with land carbon changes in general. The authors discuss the mismatch between the simulated d13CO2 compared to the ice core measurement during the late Holocene. The mismatch almost reaches 0.2 permil at 0.5 ka B.P. Elsig et al. 2009 estimated the land carbon change occurring during the Holocene to match their d13CO2 record. They suggest a land carbon uptake of 290GtC during the early Holocene (10-6 ka B.P.), followed by a 36GtC release. The simulated changes in CaCO3 sedimentation for the Holocene are quite high. Much higher than Vecsei and Berger 2004, but roughly in line with other studies (e.g. Kleypas 1997, Ryan et al. 2001). So the mismatch between simulated and observed d13CO2 during the late Holocene could be explained by an overestimated Holocene peat accumulation, or more broadly an overestimated land carbon uptake coupled with an overestimated CaCO3 sedimentation (because pCO2 follows the observation). The mismatch starts at about 4.5 ka B.P. and as also stated by the authors, I doubt it is due to anthropogenic land carbon changes. The authors briefly mention permafrost. Would permafrost thawing occur that late in the interglacial? It might be interesting to add a few sentences on the possible role of permafrost. The same could be true for the other time periods. For example, simulated d13CO2 between ~126-122 ka B.P. is significantly lower than observations.

A discussion of uncertainties associated with land carbon changes (and peat, please see comment below) could be added in the Discussion section. Additionally, the abstract could reflect these uncertainties.

2) It has been suggested that Northern hemisphere summer insolation modulates peat accumulation (e.g. Yu et al. 2010). Apart from a slightly lower accumulation rate

between 395 and 380 ka B.P., figures 4c, 7c and 10c display similar linear trends in peat accumulation rate for the 3 time periods (Holocene, Eemian and 1st part of MIS11), which is a bit surprising giving the fact that sea level variations (and thus most likely ice sheet evolution and NH insolation) are different for the 3 periods. What is the sensitivity of CLIMBER2-LPJ peat accumulation to NH summer insolation? Plotting NH summer insolation timeseries in figures 4, 7 and 10 could be useful.

Since they are a main part of the study, it would be nice to add some explanation on peat carbon changes in sections 3.2 and 3.3. In addition, maps of peatland extent and carbon density such as the ones shown in Figures 3 and 6 of Kleinen et al. 2012 would be useful.

3) Why is pCO2 decreasing between 126 and 122 ka B.P. In Eem-Orb?

Minor:

- Is Figure 1 necessary?

- Figure 5: The reference for the sea level should be added in the legend? i.e. why -3m at 0 ka B.P.?

- Figure 9: Simulated d13CO2 could be shown.

Interactive comment on Clim. Past Discuss., 11, 1945, 2015.