

Interactive comment on “Climate and carbon cycle dynamics in a CESM simulation from 850–2100 CE” by F. Lehner et al.

Anonymous Referee #1

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In this manuscript Lehner et al. presents simulated evolution of climate and the carbon cycle from the last millennium to the end of the current century using CESM model. The authors also compare CESM simulations with the simulation results of CCSM and MPI-ESM as well as available reconstruction and observational data. The authors focus on a few aspects of the evolution of climate and the carbon cycle, including the role of orbital forcing, response of climate and carbon cycle to volcanic eruption, and climate-carbon cycle sensitivity. This manuscript is a comprehensive documentation of the modeled climate and carbon cycle evolution during the last millennium. It provides useful insight into the possible mechanisms of climate and carbon cycle variability during the last millennium, though many of them need further validation using additional model simulations and reconstruction data. This manuscript is well written. I recommend its publication after the following minor issues are addressed.

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Specific comments:

2. Data and methods 2.1 Model description For the ocean carbon cycle component, how are the production and dissolution of CaCO₃ (the hard tissue pump) simulated? Please elaborate.

3 General climate and carbon cycle evolution 3.1 Temperature Page 363: "However, the uncertainties in the early period of the reconstructions prohibits to robustly answer the question whether the models are too global in their response to external forcing." "too global in their response to external forcing". What does it mean exactly? Please clarify.

3.3 Carbon cycle Page 366 "The prognostic atmospheric CO₂ increases to 1156 ppm by 2100 CE. This would imply a forcing of 7.6 Wm⁻² from CO₂ relative to 850 CE" Please clarify how the CO₂ radiative forcing was calculated.

"Together with the underestimated oceanic uptake this leads to the roughly 20% larger airborne fraction in CESM as compared to the RCP8.5." What does airborne fraction of RCP8.5 refer to and how was it calculated?

5. Volcanic forcing Page 372 "Although carbon loss due to fire increases" This should be elaborated a bit more. How is the effect of fire accounted for between the period of 850–2100CE?

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