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

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We thank the referee for his/her constructive comments. A point-by-point-response is listed below. The changes made to the manuscript will be incorporated into the revised version once we have received and been able to respond to the second referee's review.

Specific comments by referee #1:

Referee: 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.

Reply: We provide more details on this in the revised version: "Biogenic calcification

is implemented as being proportional to a fraction of small phytoplankton production, which is temperature-dependent. An exponential curve is prescribed to simulate the dissolution of sinking CaCO3 (Moore et al., 2004}. There exists no dependence of calcification-dissolution rates on saturation state."

Referee: 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.

Reply: We expanded with the following paragraph to hopefully clarify this: "A lingering question of climate modeling in general is whether models are too global in their response to external forcing. That is, they might show too little regional variability that is independent from the global mean response during a forced period. However, the uncertainties in the early period of the reconstructions prohibits to robustly answer this question."

Referee: 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.

Reply: In the same way as the radiative forcing in Fig. 1c, namely according to IPCC (2001). We clarify this in the revised manuscript.

Referee: "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?

Reply: We are referring to the CO2 concentration that is prescribed in the radiative code according to the RCP8.5 scenario (so this is not calculated, but prescribed). To clarify we expanded to: "Together with the underestimated oceanic uptake this leads

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to the roughly 20% larger airborne fraction in CESM as compared to what is actually prescribed as atmospheric concentration in the radiative code according to the RCP 8.5."

Referee: 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?

Reply: Fire activity in the model is prognostic and depends on drought conditions (soil moisture mainly) and the availability of material to burn. We changed the paragraph in the volcanic section to read: "Due to the dry conditions and availability of dead biomass there is increased fire activity, leading to increased carbon loss from land. However, the fire cannot get rid of the large amount of dead biomass immediately..." Further, we give some details on the fire module in the Methods section: "Further, it includes a prognostic fire module, which is governed by near-surface soil moisture conditions and fuel availability."

Interactive comment on Earth Syst. Dynam. Discuss., 6, 351, 2015.