

Interactive comment on “Ocean Biogeochemistry in the warm climate of the Late Paleocene” by M. Heinze and T. Ilyina

Anonymous Referee #2

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This study investigates the response of biogeochemical cycles to climate change at the late Paleocene. The biogeochemistry at the Late Paleocene is of great interest because of its hot-house climate conditions which could serve as an analog for future climate change. The authors use a state-of-the-art carbon cycle model imbedded in the MPIOM OGCM. In general the paper is well written, but can be improved by including a more sophisticated comparison with the IODP cores as done in the previous early Cenozoic modeling studies of Panchuk et al. (2009, *Geology*) and Winguth et al. (2012, *Geology*). The model has been spun-up from the fully coupled simulation of Heinemann et al. (2009), but it has not been documented how well the OGCM simulation drifts from the fully coupled simulation. A time series of the simulation (average potential temperature and salinity in 4000 m and strength of Pacific MOC) should be provided. Moreover, the simulation includes sedimentary geochemistry, but the paper

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lacks a detailed interpretation of the sedimentary changes and a comparison with the present-day sediment composition and distribution inferred from IODP cores.

Check justification of alkalinity –weathering Ca isotopes.

Specific comments:

Abstract

L.20: The pH change is linked to an increase in CO₂ invasion into the ocean (see Caldeira and Wickett, 2003, *Nature*)

L.24: Replace “sluggish ocean” with “vertically stratified ocean”

Introduction

P.1935 L.1 change “Recently, the” to “Studies of the “ L.1. delete “special” L.5 Reference: Zachos et al., 2005, *Nature* L.7 change “waters” to “water masses” L.18 16 °C above ice free temperature; reference Zachos et al., 2008

P.1936 L.2 reword “very rare” L.4 Reference: Winguth et al., 2012, *Geology* L.24 Discuss the pCO₂ value which is controversial, see e.g. Zachos et al., 2008; McInerney and Wing, 2011, *Annu. Rev. Earth. Planet. Sci.*

P.1973 L.1 Replace “sluggish” with “vertically stratified” ocean state L.26 Magnesium and calcium values vary over geologic time and corrections are required for the Late Paleocene (see Panchuck et al., 2008, and references therein). Moreover the solubility product K_{sp} is dependent on the magnesium and calcium product.

P.1940 L.2 Paleocene to present sea level change, climate change, and tectonic changes (e.g. Miller 2005, *Science*) need to be considered. This paragraph needs to include a more detailed discussion.

L11: Change “has to be given” with “has been provided” L19 30 years average of atmospheric forcing files appears to be very short because of the characteristic mixing

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time of the stratosphere. 50 years appears to be a more sophisticated value. The authors should state why this value is selected.

P.1942 L.15 Sentence unclear; reword.

P.1947 L.6 Does it mean that there is uptake of CO₂ in the Indian and Southern Ocean? Clarify sentence.

L.11 Sluggish circulation is imprecise; quantify changes in vertical stratification or changes in the MOC in Sv.

P.1948 L.11 Replace “biological production” with “export production of particulate organic carbon” Note that particulate organic carbon flux in the deep sea influences the vertical carbon gradient

P.1951 L.3 Change “poor internal mixing” to “strong vertical stratification” L.18 Specify depth.

P.1954 L.5 See major comments. A quantitative comparison with observations would make the paper much stronger.

L.12 For a detailed list of available sediment cores in the North Atlantic Ocean see Thomas, 1998; Panchuk et al., 2007; and Winguth et al., 2012. The simulated CaCO₃ distribution should be compared quantitatively with the observations.

L.5 replace “ocean stratification” with “thermal vertical stratification”

End of review

Interactive comment on Clim. Past Discuss., 10, 1933, 2014.