

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

### **Anonymous Referee #1**

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This manuscript analyzes model simulations of ocean biogeochemistry for a climate scenario of the Late Paleocene. Little is known about this time period but it serves as the background climate for PETM, which has been used as an analog for the current perturbation to the climate/carbon cycle system (rapid release of carbon). The amount of carbon has been estimated using box models or simplified models. The authors think that a more comprehensive model may lead to different results, although this is not actually shown in the manuscript. However, I think the manuscript is helpful and contributes to the understanding of this time period and hence it should be published in CP. It is well written and illustrated. I don't think this is a major advance but good enough for a paper.

Most of my points below are minor issues/suggestions, except perhaps #2 (statements

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about carbon pumps). Reading the paper I was also wondering about the P and N cycles. Would be nice if the thinking on the P and ALK inventory was elaborated on and the modeled N cycle. E.g. how does denitrification and N-fixation respond to the simulated oxygen changes and how does this affect the N inventory?

I suggest to add the recent review by Sijp et al. (2014, Global and Planetary Change 119, 1-22) as a reference.

Page 1934, line 14-15: “affects the strength and spatial variation of the different carbon pumps.” This has actually not been shown in the manuscript. I suggest to modify the manuscript or to remove the sentence from the abstract.

Page 1935, lines 20-22: “The main deepwater . . .” add references.

Page 1936, line 1: why was the lower limit of the CO<sub>2</sub> estimates chosen here?

Page 1937, line 19-20: add “online” or “offline” to clarify how the tracer simulations were done.

Page 1939, line 14: interpolated on the 3.5 x 3.5 deg grid? Which grid is shown in Fig. 1?

Page 1940, line 1: Where was the missing 14% water plus what is currently in the ice sheets?

Page 1941, lines 1-3. Does the physical state of the ocean only model converge to that of the coupled model run?

Page 1941, lines 26-27: I don’t understand this sentence. What does “adapted” mean and what “correction factor” is used for which “different pools”?

Page 1942, lines 12-15: I don’t understand. Give formula.

Page 1944, line 17-18: at what depth does the inflow of Atlantic water occur?

Page 1945, line 14. Compare to other models e.g. Sijp et al. (2014)

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Page 1946 lines 10 and 12: these two statements seem to be contradictory. First it is said that T, S control  $p\text{CO}_2$  then it is  $\text{CO}_2$  and nutrients.

Page 1948, line 1: Does the model include prognostic iron? If so, does it include sediment fluxes. Describe here or in model description section.

Page 1949, line 9-10: Compare suboxic volume to modern. How does this affect the N cycle?

Page 1950, line 8-9: “This indirectly . . .” Why?

In the model of Schmittner et al. (2008, GBC) warmer temperatures lead to an increase in  $\text{CaCO}_3$  production and rain ratio. You may want to discuss the possible reasons for these different responses.

Page 1951, line 15: I don’t understand. I thought most POC was remineralized in the upper few hundred meters of the water column, and not at 400-1,000 m depths.

Page 1953, line 7: call Fig 12.

Page 1954, lines 4-5: “Our model captures . . . well” Please show results or remove statement.

Page 1955, line 1: again the strength of the different pumps is not shown, so either remove the statement or show it.

Page 1955, lines 2-3: ditto

Page 1956, lines 5-6: Why does the lower  $\text{CO}_3:\text{DIC}$  ratio reduce the buffer capacity?

Page 1956, lines 6-7: Why does the reduced  $\text{CaCO}_3:\text{opal}$  ratio counteract?

Fig. 9: plot zonally averaged data together with present day.

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

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