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## Comment on cp-2022-8

Peter Köhler

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Community comment on "Glacial state of the global carbon cycle: time-slice simulations for the last glacial maximum with an Earth-system model" by Takasumi Kurahashi-Nakamura et al., *Clim. Past Discuss.*, <https://doi.org/10.5194/cp-2022-8-CC1>, 2022

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Results from full Earth system models with embedded carbon cycle offer the possibility to check assumption typically made during CO<sub>2</sub> reconstructions based on marine proxies. Both proxies based on boron isotopes (e.g. Dyez et al 2018, doi: 10.1029/2018PA003349; Guillermic et al., 2022, doi: 10.5194/cp-18-183-2022) and on alkenones (e.g. Badger et al., 2019, doi: 10.5194/cp-15-539-2019) - even if the latter is currently under discussion (Phelps et al., 2022, doi: 10.1029/2021GC009658) - make the implicit assumption that the CO<sub>2</sub> partial pressure in the surface waters at the site location of the sediment core drilling (typically found in equatorial waters of the Atlantic or Pacific) was in an unchanged (quasi-)equilibrium with CO<sub>2</sub> in the atmosphere. However, this assumption can only be tested against data for present day, but needs model results for assumption testing during other climate states.

It might therefore help the carbon cycle community if the glacial results of the model presented here - which at first glance seemed to cover the carbon cycle at Last Glacial Maximum pretty well - are extended on surface ocean-to-atmosphere CO<sub>2</sub> disequilibrium maps - and on how they differ from the preindustrial control run. To my knowledge such maps are seldomly found in published studies, but see one attempt with an imperfect glacial carbon cycle in Fig. 6 of Voelker and Köhler 2013, doi: 10.1002/2013PA002556. Here, especially the question if the three different glacial ocean states lead to a different disequilibrium, or if model results are robust with respect to this variable, is of interest. In doing so one would at least cover another point in time with an analysis if this assumption of unchanged surface-to-atmosphere CO<sub>2</sub> equilibrium during CO<sub>2</sub> proxy application is valid.