

## ***Interactive comment on “Carbon burial in deep-sea sediment and implications for oceanic inventories of carbon and alkalinity over the last glacial cycle” by Olivier Cartapanis et al.***

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Review of Cartapanis et al.

The authors reconstruct changes in global CaCO<sub>3</sub> burial fluxes through the last glacial cycle using a large number of ocean sediment core data and evaluate its effects on global DIC and alkalinity changes and on δ<sup>13</sup>C. They also evaluate effects of shelf burial of CaCO<sub>3</sub> and organic carbon by reducing the fluxes proportional to the shelves surface area. They conclude both changes in deep ocean and shelf burial did potentially affect global DIC, ALK and δ<sup>13</sup>C.

C1

I think this is a very nice paper with important implications for the understanding of glacial-interglacial changes in the carbon cycle. It is very well written (except for a few typos) and nicely illustrated and it is a great contribution to CP.

In my opinion the most important contribution of this paper is a quantitative reconstruction of deep ocean CaCO<sub>3</sub> burial fluxes. However, the effects of these on deep ocean DIC, ALK and δ<sup>13</sup>C are relatively small (Fig. 8A). On the other hand, shelf burial would have larger effects on DIC, ALK and δ<sup>13</sup>C (Fig. 8B) but it is not reconstructed based on data but rather based on the assumption of fluxes proportional to shelf surface area. I wonder how good this assumption is. E.g. I could imagine that most burial happens on the inner shelf and is not distributed equally across the shelf area (defined as depth < 100 m). If this is the case, then the burial fluxes may not have decreased that dramatically. I don't know if what I think is correct, but it seems to me that the shelf burial changes are more uncertain and less constrained by observations than the deep burial changes. Perhaps the authors want to entertain this thought in their discussion.

Also, I think recent papers by Wallmann and collaborators already addressed the effects of sea level changes in shelf burial and δ<sup>13</sup>C. This should be acknowledged.

P1, L15: "... removal rates, which mainly occurs in marine sediments" I think the correct syntax should be "occur". However, I'm not sure this statement is correct. If the "active" carbon inventory include terrestrial soils and vegetation and the "inactive" or "geological" inventory includes permafrost and peats, then the fluxes between the active and inactive land reservoirs may also be important at least during certain periods.

P1, L17-18: I don't think this sentence is supported by the evidence presented. I think what you wanted to say was something like "... the reconstruction provides a first order constraint on the effect of changes in deep-sea burial fluxes on carbon and alkalinity inventories over the last glacial cycle." I think this ("the effect of changes in deep-sea burial fluxes on") qualifier is needed because you don't provide constraints on the absolute (total) DIC and ALK changes, just those resulting from changes in

C2

burial fluxes.

P1, L21: "active carbon inventory" It is not clear what this is. Does it include ocean sediments? I wonder what you wanted to say with this sentence. If the active inventory includes atmosphere, ocean and land then I think it is not news that it was a dynamic, interactive component of glacial cycles.

Fig. 1: Please explain why three arrows are red.

P4, L20: Parenthesis should be after "Milliman"

Fig. 2: Consider using a color scheme readable to color-blind people (without red or green)

P6, L8: The figure says 100-150.

P6, L13-15: I thought the  $\delta^{13}\text{C}$  of buried  $\text{CaCO}_3$  was close to that of surface DIC assuming that most of the  $\text{CaCO}_3$  was produced at the surface.

P6, L30: Parenthesis should be after "Burdige"

P7, L7: Parenthesis

P9, L12: It is claimed here that the province approach is preferable. Has this actually been shown somewhere? Why could it not also be prone to interpolation and extrapolation biases?

P9, L17: Remove parenthesis with Cartapanis. Typo: it should be "assumes" instead of "assume"

P10, L13: the noaa ftp link was not working

P10, L20, 21: Please report time periods used for Holocene and LGM.

P11, L2: What are the provinces?

P11, L22: The assumption of constant shallow/deep partitioning is most likely not valid.

C3

E.g. the  $\delta^{13}\text{C}$  data suggest more DIC in the deep ocean and thus a larger surface to deep DIC gradient during the LGM. What are the consequences of this assumption for the results?

Fig. 3: What are the different lines? Labels OCEAN, SEAS, S. L. 1, S. L. 2?

P12, L1-2: The fluxes between land and the ocean-atmosphere are neglected. What could be the consequences of this assumption?

P12: Please provide the equations for the mass balance calculations.

Table 2: Why do the numbers not correspond to those in Fig. 1?

Fig. A1: Please include the numbers in the panels. I assume that 1 is the upper left and 4 is the upper right.

P13, L8: In the title please specify with MAR you're considering. I think it is  $\text{CaCO}_3$  MAR in the deep ocean, right? As opposed to  $\text{CaCO}_3$  MAR in the shallow ocean.

P15, L 7: Please provide definition of MIS5e.

Fig. 5: Label in panel E has a typo "buk" should be "bulk"

P18, L9: Syntax: replace "in" (first word) with "of"

P20, L10: Typo: "in put" should be "input"

P26, L5: I think the reference to Fig. 1 may be wrong.

P26, L15: Is there evidence for an enhanced soft tissue pump at the start of MIS4?

P30, L9: I think the first who has suggested to use deep ocean  $\delta^{13}\text{C}$  to reconstruct terrestrial carbon biomass was Shackleton (1977), Carbon-13 in Uvigerina: Tropical rainforest history and the Equatorial Pacific carbonate dissolution cycles, in The Fate of Fossil Fuel  $\text{CO}_2$  in the Oceans, edited by N. R. Andersen and A. Malahoff, pp. 401–427, Plenum, New York.

C4

P30, L12-14: This is an important conclusion, but it has already been suggested by Wallmann et al., (2016, *Clim. Past.*, page 349). BTW this reference is listed twice in the references section.

P30, L27: Where is this shown? Please refer to figure.

P31, L7: Who and how was the quality control done?

P31, L13-14: “due to enhanced soft tissue pump” I think it would be better to remove this attribution since other processes such as disequilibrium, solubility may also have been responsible for the reduction in carbonate burial.

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