Original comments are given in black, our reply is given in red.

D. Archer (Referee)

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This is a state-of-the-art calculation, the latest in a series of studies that are well described in the introduction section. The authors clearly describe the distinction between closed system behavior and open, which responds on a much longer time scale but with generally larger amplitudes.

We thank the reviewer for his valuable comments that helped to improve the manuscripts and for his time and effort to review this manuscript.

I guess the part of the simulation that is the weakest, a reflection of the state of the science rather than any deficiency in the paper, is in the calculation of organic carbon burial as a function of oxygen concentration and organic carbon deposition rate. Organic carbon burial depends also on the grain size of the sediment, and on the mineral deposition rate. River deltas can capture significant fractions of global carbon deposition. This uncertainty primarily affects the longer-term “open system” response, which is therefore much more uncertain than the shorter-term responses. The short term responses seem quite believable, and that we might actually be able to predict them. The longer term responses from model are probably better viewed as potential or hypothetical.

To make to reader aware of these shortcomings in our model, we extended the description of the model (see also answer to reviewer 4 (Wallmann)):

"Input of terrestrial organic matter into the ocean and burial of terrestrial organic matter is not explicitly considered (see e.g. Regnier et. al, 2013). Similarly, the cycling of P associated with iron and other oxides is neglected as estimates suggest that 97% of the P delivered to the sediment-water interface is in the form of organic matter (Delaney, 1998). The specific chemical composition of the organic matter, particle grain size of the sedimentary material and available area for absorption for organic matter (Hedges and Keil, 1995) as well as spatio-temporal variations in mineral deposition rates or sediment porosity, which likely influence organic matter preservation and burial (Burdige, 2007), are neglected."

In addition, we state now in the discussion section:

"There are also limitations regarding the sediment model. For example, the spatio-temporal variability in the deposition of mineral particles or the influence of particle grain size on organic matter preservation are neglected. The coarse resolution hampers the representation of coastal and continental boundaries, where most POM deposition, remineralization and burial occurs (e.g. Wallmann et al., 2012). The model does not resolve river deltas and estuaries and their carbon cycle (see e.g. Regnier et al, 2013). Another caveat is that denitrification within the sediment is not represented by our model, eventually leading to a bias in the

long-term response of POM degradation and thus burial-efficiencies. Therefore, our findings are to be confirmed and refined by a higher-resolved ocean models with a more complete representation of sediment processes."

Another frontier of science which this paper brings us to is the factors that determine the remineralization depth scale, and in particular the impact of CaCO3 sinking, as ballast, on the organic carbon sinking depth scale.

We included the following sentence in the discussion section (p495, l12 of the original MS):" It is a task for future research to advance the mechanistic understanding of the processes governing particle fluxes and remineralisation rates."

I didn't follow the discussion of the prescribed-production model run in section 3.1.2. The rational for doing it is understandable enough, as an attempt to deconvolve the impacts of changes in surface production vs. remineralization depth scale. The distinction is rather artificial, as demonstrated that the model blows up if you try to impose it for too long. But what I don't understand is the conclusion that there is no equilibrium CO2 change for the open system. There is no equilibrium for the prescribed-production model, but that's not the normal open system model.

Text clarified. We replaced 'open system' with 'prescribed-production model' (p490, l1 of original MS) to read: "Therefore, no equilibrium-changes in CO_2 can be stated for the prescribed-production model .."

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