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Biogeosciences Discussions

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Interactive Comment

Interactive comment on "Reconciling surface ocean productivity, export fluxes and sediment composition in a global biogeochemical ocean model" *by* M. Gehlen et al.

M. Gehlen et al.

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Referee: J. Sarmiento

We appreciate the critical review by J. Sarmiento and recognize that the manuscript will benefit from expanding our analysis of model results and model - data comparison. We will follow his recommendations where deemed suitable as follows:

(1) Comparison of model simulations with water column observations: We fully recognize the better data coverage available for water column data. The standard version of PISCES has been compared to dissolved properties and is fully documented in Aumont and Bopp (2006, Biogeochem. Cycles, 20(2), 2017, doi:10.1029/2005GB002591). We think, that it is not necessary to repeat this information in the present paper. For this

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study we chose on purpose data sets that are less commonly selected for model output - data comparison. Compared to dissolved species which are strongly influenced by the circulation field, particle fluxes can be considered as 1-D tracers. The use of dissolved tracers to pin down particle fluxes might be illusory at the end. Their distributions integrate the contribution of a variety of transport, mixing and chemical/biological reactions. It will be difficult to attribute specific features of a tracer field to a particular process related to particle fluxes. Extending model - data comparison to particle fluxes and surface sediment composition adds new constraints and allows to evaluate model performance in terms of the coupled pelagic - benthic system.

(2 & 3) Overall duration of model experiments: The model PISCES was run for 3000 years before starting the experiments presented in this manuscript. A thorough comparison of model results to dissolved tracers is presented in Aumont and Bopp (2006). It shows that the model has reached a quasi steady state and that the large scale distribution of modelled tracers is well reproduced. Besides the fact that limitation in computation time does not allow us to run each experiment to quasi equilibrium, the specific focus of this study calls for a rather short integration time. The emphasis is put on the description of particle dynamics and an integrated representation of the biological pump from the surface each to the bottom of the bioturbated sediment. As stated above, particle fluxes can, at first order, be considered as 1-D properties. Their response time to change in parameterisation is thus independent of the general adjustment time of dissolved tracers and short. An integration time of 100 years seems thus acceptable for our study. A duration of 100 years, that is of the order of magnitude of ventilation of the thermocline, allows on the other hand a first reorganization of dissolved tracers in response to changing particle fluxes. This explains the variable primary production reported for the individual experiments. It is a transient feature and should not be interpreted in terms of improved or degraded model fit to data. We fully agree that bottom waters are not equilibrated with respect to changes in particle fluxes induced by the varying parameterisations. This was not the aim of our study. We will improve the text to stress the rationale of our study and the admittingly short integration

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time.

(4) Model output -data comparison: We agree that the comparison between model output and observations can be made more quantitative. We will include Taylor diagrams where they will provide additional information. We will extend our comparison to include export production estimates mentioned by the referee.

Specific comments:

(1 & 2) We will improve the quality of our figures.

(3) Modelled composition of surface sediments: The modelled sediment composition is represented as the average over the mixed layer. The structures of CaCO3 distributions are well captured by the model, especially in the Atlantic. Similarly, the observed opal distribution is well reproduced in the simulation. Total organic C levels are too high in the open arctic ocean. We attribute this misfit to the ice cover occurring in these regions during part of the year. The model either predicts unrealistic values of production under the ice, or alternatively underestimates the flux of opal, both would translate into too high fluxes of particulate organic C to the sediment-water interface. We will improve the model - data comparison by modifying the figures such as to enhance their readability. The text will be updated to state the limitations of the model: exclusion of continental margins and area under seasonal ice cover.

(4) Flux-feeding: A detailed description of this feeding type can be found in Jackson (1993). In contrast to filter feeding, flux feeding is proportional to the concentration of particles and their sinking velocity. Mesoplanktic pteropods are typical flux feeders. They do not collect food by filtering water, but rather collect falling particles on a mucus web. The mucus web is ingested by the organism along with the adhering intercepted particles. This feeding type selects for faster sinking, larger particles like aggregates. It allows organisms to survive at levels of particle concentration that are too low to support filter feeders. Since the 1993 paper, the concept of flux feeding was verified in a number of field and modelling studies.

(5 & 6) The revisions of the text and the improved representation of results will clarify these issues.

Interactive comment on Biogeosciences Discuss., 3, 803, 2006.

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