

Interactive comment on “Stoichiometries of remineralisation and denitrification in global biogeochemical ocean models” by A. Paulmier et al.

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Reply to Referee 2:

We thank the reviewer for her/his very careful reading of the manuscript and the resulting constructive comments! All reviewer comments are in italics, whereas our response/action is described in roman font.

1) *The paper by Paulmier et al. describes in detail the elemental composition*

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of organic material and the remineralisation products in the classical view of e.g. Redfield. The authors set up equations for the reduction of organic matter under oxic and anoxic conditions and evaluate the oxygen demand involved in the different processes. The interesting next step they take is the comparison of their findings with the formulations used in global biogeochemical cycles. The model formulations are within the uncertainty of the theory for remineralisation under oxic conditions whereas inconsistencies become obvious in the formulations for denitrification.

The first part of paper is well written and even the very theoretical part is, after getting used to the nomenclature, easy to follow. Only a few sentences referring to side or latter aspects might confuse the reader and should be reedited (e.g. page 2547, line 7-8 point to Fig. 1 showing the formulations used in models is an unnecessary information in this part of the paper).

We removed, as recommended by Referee 2, the reference to Figure 1 in the first part of the paper.

The section 4 is not so straight forward. Some information are given without further explanation and seem to contradict latter statements: e.g. the different numbers given in paragraph 4.2 for nitrate consumption during denitrification versus oxygen consumption for HAMOCC (0.6) and PISCES (0.7) whereas in Table 2 the numbers of process ratios for CR and CD and the given quotient in the last row are very similar for HAMOCC and PISCES.

We thank the reviewer for identifying this error (which should have been our job, sorry). In paragraph 4.2, we corrected the contradictory statement concerning nitrate consumption during denitrification versus oxygen consumption for HAMOCC and PISCES, and added some additional comments and explanations.

Looking from a modeler's point of view I am missing an additional discussion on why the authors favour the formulation by Richards or Anderson and not the one by Takahashi which is used by two of the global models? How much is known about H

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excess to pin down the elemental composition on global scale?

We agree with Referee 2 that this choice is arbitrary, and other formulations as those of Anderson or Hedges (2002) could be explicitly considered in Table 2. We did not further include the formulation of Takahashi because this formulation used for HAMOCC and PISCES is concerning the oxygen demand during aerobic remineralisation only, but not concerning the complete organic matter composition inducing very important deviations on the H excess. To illustrate these deviations: aerobic H excess is 148 for Takahashi, whereas aerobic H excess is only 72 for HAMOCC and PISCES; according Hedges et al. (2002), it is 56, whereas it is negative (-80) considering amino-acids from algal proteins (Laws1991). In addition, to justify our choice, the Redfield formulation is historically the original reference, and is used here to evaluate the H excess, and the formulation of Anderson is one of the common formulations used since the last decade.

Nevertheless, we appreciate the reviewer's comment and added more discussion about H excess, taking into account the comments of Referees 2 and 1 together, especially including the discussion of the results of Hedges (2002) and of Laws (1991) on C:H in section 2. (Cf. also in Table 1).

Nevertheless, by highlighting implicit assumptions made in models the paper stimulates to think about well established formulations like the elemental composition of organic material and their representation within models. Therefore I strongly recommend this paper for publication after some minor revisions.

GENERAL COMMENTS:

1) p2542, l 9-24 I understand that the models could not be described in great detail. However I would suggest stating once the similarities of all models (e.g. HAMOCC, PISCES and BEC use fixed O2/C/P/N ratios and all three simulate cycling

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of C, O, N, P, : : :) and then mentioning differences relevant to the topic.

As mentioned also about the comments of Referee 1, we worked to improve the presentation of the different models underlying their similarities and differences, especially concerning the main assumptions.

2) *p 2550 Could you comment on any changes in the nitrate and oxygen demand in the case of anammox with nitrite coming from different sources (nitrification or denitrification)?*

As commented for Referee 1, it appears to us to be important to mention the anammox process, since the parameterization of the coupling between anammox and other process as denitrification or nitrification could have significant impact on global biogeochemical cycles. Therefore we propose to add some short comments on the changes in the nitrate and oxygen demand in the case of anammox with nitrite coming from different sources (nitrification, nitrate-reduction), but without full explicit details for the different nitrogen sources in order to avoid a too long manuscript not focused on this bacterial process.

3) *p2555, l 19-20 Anaerobic remineralisation of DOC is only necessary if the lifetime of DOC is long enough to build up significant concentrations in the suboxic zones.*

We fully agree with Referee 2, and added a complementary comment in subsection 4.1.

4) *p2556, l 26 Please comment on these numbers and if they should be identical to the ones given in Table 2, last row.*

As mentioned above for paragraph 4.2, we corrected the contradiction statement concerning nitrate consumption during denitrification versus oxygen consumption for HAMOCC and PISCES.

5) *p2559 l 3-5 Please comment on the differences between the numbers for H*

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excess, anaerobic between HAMOCC and PISCES. Given the nearly identical values that enter eq(26) it is an amazing discrepancy.

We added some comments on the differences, especially between the numbers for H excess, anaerobic between HAMOCC and PISCES in subsection 4.4.

SPECIFIC COMMENTS:

1) p2548, l 14-19 these sentences seem to be displaced and should be transferred to the end of 3.1.3

We fully agree, and displaced the sentences as suggested by both Referees.

2) p2551 l 23 typo: replace oxix to oxix

We corrected “oxix” into “oxic”, as also mentioned for Referee 1.

3) p2556 l 25 typo: replace mode to model

We corrected “mode” into “model”.

4) p253 l22 typo: replace AR to CR

We corrected AR into CR.

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