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Author Response to Editor regarding revised manuscript "Improved routines to model the ocean carbonate system: mocsy 2.0"

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Response to Editor Comment on Author Response to Referree Comment by Guy Munhoven

Here we respond to one minor comment from the Editor about lack of an Author Response to a point raised by a one Referee, Guy Munhoven. For continuity, we include below the full series of comments: the Referee Comment (in grey), the Author response (in black), the Editor comment (in brown), and finally our response to the Editor (in teal).

Page 2881, lines 10–12: The description of the method used to solve the alkalinity-pH equation is insufficient and does not appear to be correct:

1. Maier-Reimer (1993) uses the practical alkalinity approximation and specifies that a Newton iteration is used to solve the alkalinity-pH equation, expressed as a variant of the rational function form (see, e.g., Munhoven (2013) for the different forms of the equation);

2. Aumont and Bopp (2006) describe the PISCES model, which, although it derives from HAMOCC5 Aumont et al. (2003), claims to use the OCMIP protocol (i.e., Newton + bisection) for its carbonate chemistry, with practical alkalinity as an approximation to total alkalinity;

3. inspection of the MOCSY code shows that the adopted method is actually not a Newton method, as the cited literature might suggest, but, in the classification of Munhoven (2013), a fixed-point iterative carbonate alkalinity correction (ICAC) method, combined with a $\mathrm{pH} = 8$ initialization scheme.

To the best of our recollection, when O. Aumont was first developing PISCES he tried using the OCMIP code as is, but to solve the alkalinity-pH equation he switched to a faster iterative scheme coded by E. Maier-Reimer. We looked at the PISCES code back in 2004 and adopted its iterative scheme when developing the precursor to mocsy. The same iterative scheme is used in mocsy 1.0. However that will change with mocsy 2.0, for reasons we describe below. In the revised manuscript, we will do our best to clear up any confusion.

After checking and recent discussions with Olivier Aumont, we stand by our statements made in the Discussion paper about this historical perspective.

Minor comment: On page 21, line 25 of the response to reviewers, it seems to me that you did not quite respond to the concern of Dr. G. Munhoven. His comment seems directed at the undelying methodology used in your mocsy package (his point 3 on line 5, page 22), not only at the historical succession that you responded to. Could you shortly clarify this point? I have the impression that this has no effect on the revised version since you have modified the algorithm used in responding to the following comments, but would appreciate confirmation on this point.

Although the revised manuscript addresses the Referee's third point in detail, we failed to bring that forward in the Author Response. We apologize for this oversight and aim to remedy that here. Our understanding of the algorithms used in the HAMOCC3 and PISCES models comes from reading the source code of each model and speaking with its authors, not from short statements made in publications that may be imprecise and that did not permit verification because of lack of source code. In our original Discussion paper, we never stated that mocsy adopted a Newton method. That was the Referee's interpretation based on what he had read in literature that we had cited. On the other hand, we said on p. 2881 (lines 10-12) while referring to mocsy 1.0 that "Its development began by combining the Fortran code for equilibrium constants from OCMIP2 and the efficient iterative algorithm to solve for pH (Maier-Reimer, 1993; Aumont and Bopp, 2006)." The same sentence is kept in the revised manuscript. Furthermore, we added a new subsection (2.1.2) dedicated to clarifying what algorithm was used in mocsy 1.0 (ICAC, now specified by name) and, more importantly, how that has been changed in mocsy 2.0 to the Munhoven (2013) algorithm, which is faster and converges even under extreme conditions. We confirm then that this issue is no longer relevant for the revised code (mocsy 2.0); nonetheless, the revised manuscript leaves no room for doubt about what algorithm was used in mocsy 1.0.

References

references

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