Geosci. Model Dev. Discuss.,
doi:10.5194/gmd-2016-155-AC1, 2016

Geoscientific Model Development Discussions

Interactive comment on "Biogeochemical protocols and diagnostics for the CMIP6 Ocean Model Intercomparison Project (OMIP)" *by* James C. Orr et al.

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Received and published: 28 November 2016

Response to Short Comment by T. Lovato

This Short Comment is repeated below in gray; our response follows in black. We thank Tomas Lovato for these helpful comments.

This manuscript documents the experimental protocol for the biogeochemical and inert chemical tracers under the CMIP6 Ocean Model Intercomparison Project (OMIP), here referred as OMIP-BGC. The description of simulations protocols, preferred

parameterizations, and diagnostics is very thorough and it provides a good guidance for all the groups involved in this intercomparison exercise. I have few comments on aspects related to the protocol definition.

1- At the beginning of section 2, authors strongly advise to use the constants recommended in best practices described by Dickson (2010). However, Orr and Epitalon (2015) clearly pointed out that some exceptions to the best practices might become relevant when dealing with numerical models. I think that the protocol could be revised by pointing out the use of more suitable parameterizations, like e.g. K1-K2 from Millero (2010) and KF formulation in Dickson and Riley (1979).

These points will be addressed more thoroughly in the revised manuscript. Orr and Epitalon (2015) do discuss the Millero (2010) formulations for K_1 and K_2 relative to those recommended for best practices. However, the companion paper (Orr et al., 2015) identified internal discrepancies with the Millero (2010) formulations, recommending to remain with the best-practice formulations until those discrepancies are resolved. We will provide an updated analysis of this situation for K_1 and K_2 in the revised manuscript. Regarding K_F, the choice between the two available formulations (Dickson and Riley, 1979; Perez and Fraga, 1987) does not make a significant difference in computed variables (Dickson et al., 2007; Orr et al., 2015). Indeed some of the public software packages that make these carbonate chemistry calculations (e.g., various versions of CO2SYS) do not even offer a choice.

2- The protocol for simulations indicates that initial conditions for DIC an TA are based on the recent GLODAPv2 (see section 2.2). In particular, these data are provided over two distinguished time periods, namely from 1986–1999 for the WOCE era and from 2000-2013 for the CLIVAR one (see Kay et al., 2015). It would be very useful to report in the manuscript how these data will be handled to create the initial conditions (use

only one period, data blending, etc.), especially if one consider that DIC is remarkably time-dependent over long time windows.

In theory, either the first or second period could be used for initial conditions if pre-treatment of the GLODAPv2 data would include removing the anthropogenic DIC component (or part of it) based on data-based estimates (e.g., Khatiwala et al., 2009). The revised manuscript will discuss this point and stipulate the preferred option.

3- In section 2.5.3, it is indicated that in-situ temperature and salinity in permil units have to be used in the computations related to the carbonate system. I think that the preferred type of these two variables could be addressed more precisely, e.g. in situ temperature as ITS-90 and Practical Salinity as PSS-78, also to comply with the routines used in mocsy.

These specifications of the T and S scales will be added to the revised manuscript.

4- In the companion paper on OMIP physical experiments (Griffies et al., 2016) it is considered also the use of most recent Equation of State for ocean physics (TEOS-10), which relies on Conservative Temperature and Absolute Salinity. This might represent a critical issue since equilibrium constants were all derived using practical salinity (Millero, 2007; Dickson, 2010). I guess that some guidelines on the use of the most appropriate conversions tools between different formulations of temperature and salinity should be addressed in the protocol description.

For these conversions, the revised manuscript will recommend that model groups should use the routines from the TEOS-10 Fortran library, available from http://www.teos-10.org/software.htm.

5- I think it would be very useful to have a table that summarizes the requested variables for each Tier and link them to the specific experiments of both OMIP-BGC and DECK.

We will consider this as an option for the revised manuscript while weighing the concern of excessive duplication. The publicly available CMIP6 data-request tables for OMIP will contain the same information and can be sorted by individual modeling groups according to their needs.

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