

Interactive comment on “Evaluation of the Transport Matrix Method for simulation of ocean biogeochemical tracers” by Karin F. Kvale et al.

Anonymous Referee #1

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General Comments:

This paper provides relevant scientific information on the differences in biogeochemical tracers between running a biogeochemical model in conjunction with an online OGCM versus running the same biogeochemical model offline using the Transport Matrix Method (TTM), when the transport matrices are based on exactly the same OGCM. Comparisons are made for key biogeochemical tracers (nitrate, phosphate, oxygen) and for phytoplankton biomass (diazotrophs, other phytoplankton). The authors conclude that the differences are relatively minor compared to the differences between observations and the modeled values.

For the OGCM used, the University of Victoria Earth System Climate Model, an additional benefit of using the TTM approach is the feasibility of parallelism in the imple-

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mentation. This resulted in two orders of magnitude gain in the wall-clock time needed to run the biogeochemical model.

The paper is well organized, and quite readable. The use of Taylor diagrams to contrast the results is helpful in summarizing the differences. There is sufficient detail about how this was implemented to facilitate reproducing the results.

It is unfortunate that basic changes to the advection scheme of the online OGCM and a compensating parameter change in a diffusion parameter were required in order to facilitate generation of the transport matrices. That means that the transport matrices are derived from a different version of the OGCM than the version with which the biogeochemical model is usually run. Comparisons of the results using the two OGCM versions are given; and comparisons of results using the modified OGCM and the TTM model are given. What is missing, as a practical matter, is a comparison of the biogeochemical results using the standard OGCM with the results using the TTM model.

Specific Comments:

Page 1, Line 9, forward: The paper abstract needs to inform the reader that modifications to the OGCM were necessary in order to make it feasible to extract the TMs.

Pg. 2, line 22, forward: This line implies that the ocean component of the ESCM was always run along with the atmosphere-biosphere-cryosphere-geosphere, since there is no statement to the contrary. Is this correct? If not, state which components were run in conjunction with the ocean model. This is particularly important in order to set the context for the great gain in the computer time that was made using the TTM.

Were the forcings being used representative of the current era, without increased warming? Please state what forcing scenario was used.

Please give a little more in the description of the biogeochemical model; such as NZPD (declared later), and what phytoplankton groups, grazers, and nutrients are being tracked.

Page 6, oxygen: It is mentioned that diazotrophs are disproportionately sensitive to low oxygen levels, as denitrification can be triggered. Small differences spatially in suboxic conditions can have significant impact. The extent of these differences between the OGCM and TTM in the modeled low oxygen, and where the low oxygen regions occur, needs to be shown.

Technical Corrections:

Pg. 1, Line 8: Insert “course-resolution” after “widely used”.

Pg. 1, Line 9: Replace “for” with “from”.

Pg. 1, Line 23: Replace “GCM” with “OGCM”.

Pg. 2, Line 24: Delete “bug fixes and”.

Pg. 4, Line 4: If possible, explain the effect of this (such as making the TMM model 5 times slower), so that the trade-off can be better understood.

Pg. 5, Line 21: Modify “the impact of the advection scheme” to “the impact of the differences in the advection schemes” (or similar).

Pg. 6, Line 33: Insert before “offline and online models”, “ the biogeochemical component of the”.

Pg. 7, Line 1: Insert after “monthly in these experiments”, “compared to [what time period] in the online simulation”.

Pg. 7, Line 16: “it’s” should be “its”.

Pg. 7, Line 24: End the sentence “with respect to observations”. Period. The hundred-fold improvement in the time is a separate benefit of the particular implementation because of the added parallelization.

Pg. 7, Line 28: Insert “biogeochemistry” at the beginning of the line, before “ in a few hours”.

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Pg. 7, Lines 19 forward: It might enhance the clarity of the conclusions to split this into two paragraphs, one on the biogeochemical results comparison, and another on the large improvement in the computer time required.

Pg. 13, Fig. 2, forward: State that the top panels are zonal averages (assuming that they are).

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