Geosci. Model Dev. Discuss.,
doi:10.5194/gmd-2017-29-RC3, 2017

Geoscientific Model Development Discussions

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

Anonymous Referee #3

Received and published: 22 March 2017

In this study, the authors extract a transport matrix model (TMM) from the ocean component of the UVic Earth System Climate model, and use the TMM to spin-up the biogeochemical component of the model. The biogeochemical state of the TMM-model is then compared to an identical simulation using the online circulation model. Overall, this paper provides a useful comparison of the TMM spin-up method to the online method, and shows that the TMM faithfully represents most aspects of the online model, at a fraction of the computational time.

This paper is well-written and appropriate for publication in Geoscientific Model Development. However, there are quite a few points in the paper that need to be expanded on and/or clarified in a revised manuscript. These are listed below.

Page 4, line 2: "time-stepped with a simple Euler method": Euler forward or Euler

backward?

Page 4, line 3: "Fourier filtering at high latitudes": Some more discussion of this would be useful. Why is this filtering applied? What is the underlying cause of the noisiness? What numerical grid scheme (e.g. Arakawa B, C etc.) does the model use?

Page 4, line 7: "Monthly mean TMMs were extracted": More information about how this was done is needed here. What time-step was used in the online model to create the TMs? How was the monthly averaging done?

Page 4, line 20 ff.: These few lines of description are not sufficient. More information is needed here to better describe how the biogeochemical model is coupled to the TMM. Equations and/or pseudocode would be appropriate so that one does not have to download and wade through the code.

Page 4, line 30: Why does the MOC weekend when switching from the FCT to UW3 advection schemes? Some discussion of this is needed.

Page 5, line 25: Why is alkalinity sensitive to small changes in oxygen?

Page 5, "Mean state" section: Define the "mean state" of the TMM model and the online model. Are they directly comparable? Presumably the "mean state" of the TMM model is the annual average of the seasonally-cycling model which represents year 13001 i the online model âĂŤ is that correct? Is the mean state of the online annual average of the 13001st model year? Or is it the multi-annual average of some range of years âĂŤ and thus would include natural inter annual variability as well? This needs a careful description, and if the two "mean states" are not directly comparable, this should be discussed.

Figure 9: Oxygen: It would be useful also to show the suboxic/hypoxic volume for the TMM and online models. Do they match up well? And related to this, the water-column denitrification rate in each model âĂŤ how does it compare? This is an important biogeochemical process that is highly sensitive to the details of the oxygen distribution.

It is important to know if the TMM version of the model captures the behavior of the online model.

Page 6, line 15, and Figures 10 and 11: “Polar filtering” is blamed for the mismatch at high latitudes. Seems likely that this is not the cause. The mismatch is not really in the “polar” regions - is this filtering really applied at 50-60oS in the ACC? Also, the nutrients are too high in the surface S. Ocean and too low in the deep S. Ocean âĂŤ this seems to implicate the biological pump (e.g. particle formation/sinking) as the culprit. A more careful discussion of these differences and their possible causes is warranted.

Section 3.2.2 “Seasonal cycle”. More discussion of how the seasonal cycle is handled is needed. Equations are needed. Is there a separate TM for each month? And then Euler forward (or backward) is applied to time-step the model? I’m assuming this is the case, but this should be made explicit. In regards to the difference between the TMM and online model, for example as seen in the Indian Ocean for phosphate (Fig. 14), how much is due to the time-averaging of the TMM, and how much to the time-stepping scheme? Would some of these differences be reduced with a more robust time-stepping scheme? e.g. Adams-Bashforth or Crank-Nicholson.

Interactive comment on Geosci. Model Dev. Discuss., doi:10.5194/gmd-2017-29, 2017.