Reply to Editor's Comments and Suggestions

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Title: A single-column ocean-biogeochemistry model (GOTM-TOPAZ) version 1.0

We appreciate your considered comments and suggestions, which have proven very helpful in improving our manuscript as well as very valuable in guiding our future research. We have made some revisions to the manuscript in accordance with your comments. The revised portions of the manuscript are marked in red, while our detailed responses below are given in blue.

We greatly appreciate the time and effort you have given to assessing our work and, once again, we thank you very much for your kind comments and suggestions.

Editor

[General Comments]

Thank you also for your revised manuscript and response to reviewers. While I feel that in the context of a GDM paper, many of the points have now been addressed or are not of major concern, there are a small number of further changes which I would like to see before I can make a final decision (potentially with the help of the reviewers).

: Thank you for your meaningful review and comments. We addressed each of the specific comments and responded to them individually below. We hope that the revised manuscript is now ready for publication.

[Specific Comments]

1. "The main issue which I would like you to consider further is the the more complete integration of the additional site into main manuscript. I share the reviewers concerns that the main site you have chosen has not been demonstrated to be well suited for 1D modelling, and as such it is hard for the reader to get a good feeling for the true skill of the model. Assuming that you can adequately justify that the two additional sites are suitable locations for 1D modelling, please can these be given equal weight to the 1st site in the main manuscript. I appreciate that this might require some consolidation and reorganisation of figures."

: Thank you for the useful comment. The majority of observation points in the sea off the Korean Peninsula have been located on the paths of either the Tsushima Warm Current or the East Korea Warm Current. Besides, there are only a few points at which biogeochemical variables have been observed over a long period of time (at least 10 years). This provided us with a constraint for selecting points from which observed values that were necessary to verify the model could be obtained.

We selected the observation points by considering the continuity and quality of the ocean biogeochemical observation data. Point 107 is located where the North Korea Cold Current and the East Korea Warm Current meet. This area is biogeochemically important and has been actively studied with respect to the variations in the main fish species and catch according to phytoplankton characteristics (size or toxic/non-toxic) (Joo et al., 2014; Shin et al., 2017). The other two points 104 and 102 are located on the path of the East Korea Warm Current. Warm eddies are also observed at these points. Of course, as these points are greatly affected by the ocean current, extra attention needs to be paid when verifying a single column model (SCM).

Despite such a disadvantage, if GOTM-TOPAZ produces meaningful results, the expendability of the model (that is, the applicability to various observational points) will be proven. We expect that

out model will be applied to many ocean biogeochemical investigations and be suitably tuned for each area. Following the editor's request, we have added analysis results about the additional two points (104, 102) in the manuscript.

Joo, H. T., Park, J. W., Son, S. H., Noh, J.–H., Jeong, J.-Y., Kwak, J. H., Saux-Picart, S., Choi, J. H., Kang, C.-K., and Lee, S. H.: Long-term annual primary production in the Ulleung Basin as a biological hot spot in the East/Japan Sea, J. Geophys. Res. Oceans, 119, 3002–3011, doi:10.1002/2014JC009862, 2014.

Shin, J.-W., Park, J., Choi, J.-G., Jo, Y.-H., Kang, J. J., Joo, H. T., and Lee, S. H.: Variability of phytoplankton size structure in response to changes in coastal upwelling intensity in the southwestern East Sea, J. Geophys. Res. Oceans, 122, 10, 262–10, 274, doi:10.1002/2017JC013467, 2017.

2. "Finally, I appreciate the changes you have made to avoid over-representing the skill of the model in the text. I would like to see this go further. For example, where you have looked at profiles, there are places depths at which the absolute values of variables are correct, but it is on a background of a profile which is of the wrong shape. Given the nature of a 1D model, where processes are occurring only vertically, my assumption in most cases is that if (for example) the middle part of the profile matches the absolute values of the observations, but the top and bottom of the water column are wrong, this has to arise through the cancellation of errors rather than inherent skill. Please can you therefore further revise the validation component of the text. The important thing for GMD is not that the model is highly skilful, rather that it is impartially evaluated so that other potential users can simply understand the model and its performance."

: We agree with the editor's comment that the similarity of the biogeochemical variables between our model simulation and the observational results might be attributed to the cancellation of errors (irrespective of the performance of the model). Accordingly, following the editor's suggestion, we have revised the validation component. As for dissolved oxygen, the bias was larger in summer, and there was also a bias in the deep sea (< 250 m). For this reason, we analyzed the magnitude of the source and sink terms instead of vertical diffusion.

The production of dissolved oxygen is attributable to nitrate, ammonia, and nitrogen fixation (caused by phytoplankton), while the loss occurs during the production of NH_4 from non-sinking particles, sinking particles, and nitrification (Dunne et al., 2012b). As shown in Figures 8, 9, and 10, the model excessively simulated dissolved oxygen in the surface layer (< 60 m) in the summer. This seems to be because the photosynthesis of phytoplankton is dominant. In addition, our model tended to underestimate dissolved oxygen in the deep sea (> 250 m). This error was (significantly) reduced by using the observations for the initial data. We found that our model was sensitive to source/sink terms in the surface layer and initial values in the deep sea. Other variables showed a similar result. Accordingly, model users need to consider this characteristic of GOTM-TOPAZ while conducting an experiment. We have added this point to the Abstract, Results, and Discussion.