Title: Numerical Models for Monitoring and Forecasting Ocean Biogeochemistry: a short description of present status
Author(s): Gianpiero Cossarini, Andy Moore, Stefano Ciavatta, Katja Fennel
MS No.: sp-2024-8
Report: Ocean prediction: present status and state of the art

Dear Editor,
We thank the 3 reviewers for their positive comments. Their requests have been carefully considered. In the following reply letter, reviewers' comments are in **bold green**, the answers in black and the proposed revised text in blue.

RC3: 'Comment on sp-2024-8', Anonymous Referee #3, 25 Oct 2024 reply
Review of "Numerical Models for Monitoring and Forecasting Ocean Biogeochemistry: a short description of present status"
By Gianpiero Cossarini, Andy Moore, Stefano Ciavatta, and Katja Fennel
The paper provides an overview of the biogeochemical models used for operational oceanography today. It provides basic information about how marine biogeochemical models are coupled with ocean general circulation models and discusses uncertainties related to parameterisations, initial conditions, and the lack of observations. The paper is well written and organized. With the understanding that is is not a classical science paper, but an overview in the context of a report on operational oceanography, I have only a few comments and corrections listed below:
We thank the reviewer for her/his positive comment

Specific comments
Line 32: "… while detailed descriptions and discussions can be found in the following articles ". It sounds like these three papers are the definitive list to read if you want to read all about models in operational oceanography, I suggest to change "while" with "more".
Done

Line 57: "Rather, equations describing biogeochemical processes rely on empirical relationships based on laboratory experiments (e.g., nutrient limitation experiments, grazing dilution experiments), biological theories, and ecological principles based also on biogeographic relationships." Here you should also mention conservation of matter, which is one solid principle that can be applied in these models.
The principle of conservation of mass is introduced at old lines 44-45 as follows:
The last term, R_{bio}, represents the local source-minus-sink terms for the biogeochemical tracers and is typically based on the principle of conservation of mass to simulate the cycling of chemical elements through various marine compartments.

Line 97: I am uncertain about what you mean by this regarding the subdivision of zooplankton "and its role within an end-to-end ecosystem approach (Mitra et al., 2014)." Is this with respect to who eats them?
We agree, the sentence was not clear and it will be removed. Mixotrophy is introduced in the next sentence.

Line 119: I suggest to include this paper by Bieser et al., 2023 in the reference list (https://doi.org/10.5194/gmd-16-2649-2023)
Thanks for the suggestion. The new reference will be added.

Bieser, J., Amptmeijer, D. J., Daewel, U., Kuss, J., Soerensen, A. L., and Schrum, C.: The 3D biogeochemical marine mercury cycling model MERCY v2.0 – linking atmospheric Hg to methylmercury in fish, Geosci. Model Dev., 16, 2649–2688, https://doi.org/10.5194/gmd-16-2649-2023, 2023.

Line 122: I think there are quite a few physical models (even if there are more biogeochemical models). I think it would be better to highlight that physical models solve the same equations, but differ mainly in how they are discretized on the horizontal and vertical grid. Physical models also differ in how they parameterized subgridscale processes. Biogeochemical models, on the other hand, solve entirely different sets of equations, in addition to being discretized on different grids and having to parameterize processes that are not included explicitly.
The aim here is only to present the large variety of biogeochemical models used in operational systems, while the number of dynamic ocean models is relatively smaller. A complete list of physical models (and a discussion on their characteristics) is the goal of another chapter of this collection (Bell et al., 2024). We would prefer not to change this sentence unless the reviewer suggests it.

Bell, M.J., Drillet, Y., Martin, M., Schiller, A., Ciliberti, S. (2024). Numerical Models for Simulating Ocean Physics. State Planet Discuss. [pre-print], https://doi.org/10.5194/sp-2024-41

Line 140: PICES also exists with variable stoichiometry (PISCES-QUOTA), but the version used operationally uses constant stoichiometry, this should probably be mentioned.
Thanks for the suggestion. We will add a sentence on the PISCES-QUOTA version:
A version with variable stoichiometry (PISCES-QUOTA) also exists and is used for climate scenario studies (Kwiatkowski et al., 2018).

Kwiatkowski, L., Aumont, O., Bopp, L., & Ciais, P.: The impact of variable phytoplankton stoichiometry on projections of primary production, food quality, and carbon uptake in the global ocean. *Global Biogeochemical Cycles*, *32*(4), 516-528., 2018

Technical corrections/language
Line 40-41: Use subscript H and V in KH and KV.
Done

Line 49: Suggest: "Different schemes can be used to couple the physical and biogeochemical processes to optimize accuracy and computational cost (Bruggeman and Bolding, 2014; Cossarini et al., 2017)."
Done

Line 78: to define = for
Done

Line 108: The microbial…
Done

Line 117: Just nekton ("organism" is unnecessary)
Done