Comment on "Numerical Models for Monitoring and Forecasting Ocean Biogeochemistry: a short description of present status"

Anonymous Referee

General Comments

The manuscript provides a comprehensive overview of the current state of biogeochemical modeling in the context of operational oceanography. The authors have successfully outlined the complexity of these models, the various approaches used to couple biogeochemical processes with physical oceanographic models, and the challenges associated with parameterization and computational costs. The manuscript is well-structured, and the use of specific examples from different modeling systems enhances its clarity and relevance. The paper is a valuable contribution to the field, offering insights into the advancements and ongoing challenges in marine biogeochemical modeling.

Specific Comments

1. **Introduction:**

The introduction effectively sets the context for the discussion, presenting the main aspects of modelling. However, it would benefit from highlighting the importance of biogeochemical modelling for understanding marine ecosystems, giving more details on the practical applications and implications of these models for marine resource management and policymaking. The reader would like to know why modelling ocean biogeochemistry is important. What is at stake?

2. **Basic Formulation and Processes of Biogeochemical Models:**

The section provides a clear and concise explanation of the fundamental principles behind biogeochemical models. Including a schematic diagram of a typical biogeochemical model could further enhance the readers' understanding.

The discussion on the NPZD approach is thorough, but it would be useful to compare this approach with other modeling frameworks, highlighting their respective strengths and limitations.

The manuscript explains the trade-offs between model complexity and computational cost. It would be beneficial to include a table summarizing the key features and applications of the various models discussed (e.g., HadOCC, SCOBI, NEMURO, etc.).

The section on the incorporation of additional components (e.g., metals, POPs) into biogeochemical models is particularly interesting. More examples of how these components have been successfully integrated and validated in existing models would strengthen this section.

Even if it's not the focus of the paper, the discussion on data assimilation could be developed further. The manuscript could delve deeper into the specific challenges and potential solutions related to assimilating different types of observational data (e.g., satellite data vs. in situ measurements).

The role of emerging technologies, such as autonomous underwater vehicles and biogeochemical Argo floats, is briefly mentioned. Expanding this discussion to include recent advancements and case studies would provide a more comprehensive view.

The title of this section is a little reductive in relation to all the aspects covered. I suggest rewording the title or dividing it into several subsections (ex: basic formulation, coupling, model complexity, data assimilation, main models used...).

3. Conclusions:

The conclusions summarize the key points effectively but could be expanded to include a forward-looking perspective on the future of biogeochemical modeling. What are the emerging trends and technologies that could shape this field in the next decade?

Discussing the potential for interdisciplinary collaboration and the integration of biogeochemical models with socio-economic models could provide a broader context for the readers.

Technical Corrections

Introduction:

- The definition of 'reanalysis', 'hindcast' and 'nowcast' may vary depending on the application, methodology, community or context. A definition of these terms should be provided.

- Line 30, cite some pollutants in brackets to help the reader.

Equation Formatting: Ensure that all equation terms are consistently formatted and clearly presented. For example, line 40, KH should be written K_H (with H as a subscript). Please check all terms (KV, Rbio...).

References: Please check that all works cited are included in the reference list and that all references are correctly cited in the text. Please also check the spelling of the names mentioned and the year of publication. There are many typos... This list below is not exhaustive, please check each reference...
-The text refers to Daewl instead of Daewel, Gutkenecht instead of Gutknecht.
-Vichi et al (2007), Vichi (2015), Yumruktepe et al (2023) are cited in the text but not included in the reference list.
-Vichi et al (2017), Yumruktepe et al (2022) are mentioned in the Reference list but are not cited in the text.

Acronyms: All acronyms and chemical products should be defined when first used. For example: DMS HTL, POPs, CDOM...

Typographical Errors

Line 26: " process-base" should be " process-based".

Line 38: "compartmens" should be "compartments"

line 90: "plankton functional groups" should be "plankton functional types" to be consistent with the acronym PFTs

Line 141, remove the dot before the reference Aumont et al (2015)

line 150, please check: "multinutrients and multi-plankton several", something is wrong