

Review on „Radiation model for the Baltic Sea with an explicit CDOM state variable: a case study with Model ERGOM (version 1.2)“ by T. Neumann et al.

The study is dedicated to augmenting the MOM-ERGOM-based model system of the Baltic Sea by accounting of the effect of the light absorption by coloured dissolved organic matter (CDOM) when modelling the light path with implication on the biogeochemistry of the basin. Moreover, to simulate more precisely the light attenuation due to CDOM, the authors consider this optical constituent as an additional model variable, that has not yet been incorporated in the biogeochemical cycling. Neither the authors consider a part of CDOM produced as a result of phytoplankton functioning, but rather first as a tracer of a terrestrial origin, which is, nevertheless, crucial - and makes such an implementation valuable, - for the investigated basin. In this respect the study suits the frame of the journal. The strongest part of the presented study is the exploiting a satellite CDOM data product for representation of the CDOM loading by rivers (for specification of model CDOM boundary conditions). My comments mostly concern the manuscript's structure (clarity) and quality of the figures, which needs to be improved. Below I listed a number of comments/suggestions the authors might want to consider and address in a revised version of the manuscript. After such a revision I would recommend the paper for publishing.

General comments:

- 1) An edit is required for the title (please follow recommendation of reviewer 1)
- 2) In the abstract, please present more precisely the evaluation results (including comparison of “the traditional” approach). How exactly did the model performance with the new light attenuation parameterisation improve, given which particular evaluation criteria?
- 3) Introduction should be extended more intensively by references to the state-of-the-art of the investigated problem and related studies (see my specific comments), which would show the present study in line with already existing research and would further emphasise the added value.
- 4) The manuscript could benefit from a restructuring. In particular, Part 2: I would suggest to introduce/organize a separate section: **2 Methods and data** and started first (Section 2.1) with model description
 - general (MOM-ERGOM) model description
 - Radiation (optical) model development
 - o Implementation in ERGOMfollowed by
 - data description (Section 2.2) including data processor *etc.* to prescribe required boundary conditions;
 - and further details on the experiment set up including forcing and initial conditions and further followed by validation/evaluation metrics (Section 2.3)
- 5) Generally, I would also recommend elaborate a bit more on the results (however I do not list specific comments with respect, except for a request on quantitative estimates of the discussed correlations).

Specific comments:

P1. L13-16: It would be nice to support your statements by related references (sentence-wise).

P1. L17: Please add related references in support to the statement ("*Water temperature is affected by CDOM absorption as well*"). For instance:

Hill, 2008; Kim et al, 2015; Kim et al., 2018; Gnanadesikan et al., 2019, Soppa et al., 2019, Pefanis et al. 2020.

L19: Provide related references

P2. L2: Even for open ocean several studies showed a better representation of the light path when explicitly accounting for light absorption by chlorophyll and CDOM (Kim et al. 2015, Kim et. 2016, Groeskamp&Iudicone, 2018, Pefanis et al., 2020). Nevertheless, I agree that for coastal ecosystem it is extremely crucial (Cahill et al. 2008; Jolliff&Smith, 2014; Juhls et al. 2020).

P2. L3: I would suggest "parameterisation of light (penetration)" instead of "parametrization of model"

P2. L4: "autochthonously" instead of "autochthonous"

P2. L14-15: the authors might want to add the following references:
Dutkiewicz et al. 2015, Pefanis et al. 2020

P2. L15: "**In relation to the Baltic Sea**, a necessary prerequisite"

P2. L19: A rephrase is required: "... we discuss the effect of the new development (proposed model extension?) on the ... Baltic Sea ... "

P2. L21: please consider editing of this sentence.

P3. L7-9: An edit is required for this sentence. As an example:

"It utilizes an artificial neural network (ANN) first to remove ... and then to estimate ... "

P3. L11: "gelbstoff" - please use English term :-)

P3. L11: "440 nm" (space in between)

P3. L12: "measurements from Finland" - please provide a related reference and/or link

P3. L15: "... **by** Koponen et al. (2007) **and** Attila et al. (2013)."

P3. L20: "The cases..." instead of "Cases"

P5. L2: I would suggest: "as in the study by Neumann et al. "
instead of "proposed by"

P5. L17-18: please provide a supporting reference to the statement.

P5. Equation 8: please edit the integral part of the equation.

P6. L16-21: consider combining the corresponding text in one paragraph.

P7. L7: "0.5 m" and "2 m" instead of "0.5m" and "2m"

P7. L19: CDOM as a product of phytoplankton is neither considered. Right?

Part 4: since there is no a discussion part, the best title would be "Results and discussion" (not just "Results")

P7. L27-28 (second sentence of Part 4): strictly speaking it might also impact the physics, but probably not in the current set up... Somehow, it was not clear enough from Parts 2/3 if the authors consider CDOM effect on the shortwave radiation penetration (and related physical processes) in general or only as a role of CDOM absorption in attenuation of the light available for phytoplankton production/growth. Please provide required emphasises.

P7. L28-32: these sentences should belong to the "Method" part.

P9. L4-3: "the correlation is low" – please provide quantitative estimates if possible.

P9. L4-5: "correlation improves ..." – provide the quantitative estimates ($r = \dots$)

P9. L13-20: The text belongs to one (joint) paragraph.

P9. L31-32: might belong to the "Method"

Part 5 Conclusions: reads rather as "Summary and conclusions"

P10. L7: editing is required for "an approach for light absorption"

As a suggestion: "...an approach for accounting for the light absorption due to ..."

Or "...an approach for approximating/considering the light absorption due to ..."

P10. L10: "A common approach uses CDOM-salinity relationship for ..."

Readds too general, please rephrase, since not all studies in existence use CDOM-salinity relationships to represent CDOM in models.

P12, L5: the authors might want to refer to the study by Dutkiewicz et al. (2015).

Figures

Figures 2, 4: to improve the quality of the figure please increase the size of the font used.

Figure 3: increase the size of the figure panels.

Figure 6 caption: "... based on its relation to salinity" instead of "based on salt."

References:

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- Gnanadesikan, A., Kim, G. E., & Pradal, M.-A. (2019). Impact of colored dissolved materials on the annual cycle of sea surface temperature: Potential implications for extreme ocean temperatures. *Geophysical Research Letters*, 46, 961– 869. <https://doi.org/10.1029/2018GL080695>
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- Hill, V. J. (2008). Impacts of chromophoric dissolved organic material on surface ocean heating in the Chukchi Sea. *Journal of Geophysical Research*, 113, C07024. <https://doi.org/10.1029/2007JC004119>
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- Soppa, M. A., Pefanis, V., Hellmann, S., Losa, S. N., Hölemann, J., Martynov, F., Heim, B., Janout, M. A., Dinter, T., Rozanov, V., & Bracher, A. (2019). Assessing the influence of water constituents on the radiative heating of Laptev Sea shelf waters. *Frontiers in Marine Science*, 6(221), 1– 13. <https://doi.org/10.3389/fmars.2019.00221>