

Geosci. Model Dev. Discuss., referee comment RC1  
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## Comment on gmd-2021-279

Anonymous Referee #1

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Referee comment on "ECOSMO II(CHL): a marine biogeochemical model for the North Atlantic and the Arctic" by Veli Çağlar Yumruktepe et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-279-RC1>, 2021

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The paper presents and evaluates an updated version of the marine biogeochemical model ECOSMO II, that now also includes a parameterisation for a variable C:Chl ratio of phytoplankton. The biogeochemical is coupled to the HYCOM ocean model, configured for the Arctic Ocean. Model evaluation of a default setup is carried out against observed nutrients and Chl a from in situ measurements and remote sensing, and complemented by comparison to literature values of primary production. Model sensitivity to biogeochemical parameters is evaluated in two further experiments. In general, all model configurations perform quite well with regard to the observations, and improvement in surface chlorophyll when parameters are adapted to the hydrodynamics of the Arctic.

In general, the paper is well written and I very much appreciate the thorough comparison to observed tracers. One drawback is the - to my eyes - somewhat incomplete description of phytoplankton (see (1) below), and the slightly confusing description of how observations were used for comparison (2). I further encourage the authors to improve on the structure of the paper (3) and to extend a bit on the comparison of the three different experiments (see my comment no 4 below).

(1) For better understanding of how phytoplankton responds to nutrient and light limitation I suggest to present the equation(s) for  $\phi$  (in Eqns 1 and 2). Without knowledge about this functional form it is difficult for the reader to understand its dynamics, in particular as DS2013 might not be accessible to everyone. Further, does the C:Chl ratio (or the amount of chlorophyll in phytoplankton) affect the light attenuation and P-I curve, i.e. the of phytoplankton growth rate?

(2) The description of type of observations, and how these were used for model evaluation (section 4.1) is somewhat confusing (see also below, specific comments).

(3) Some sentences of the model setup (section 3) already anticipate the results (e.g., lines 183-186: "Using lower ... column stabilizes." and 189-191: During the continuous ... will replace the parameterization set in EXP2."). I would suggest to reorganise the paper a bit (see also comment (4)), and draw conclusions only from the model evaluation.

(4) I enjoyed reading the analysis in section 4.3. I think this analysis could be complemented by contrasting it with the results obtained with EXP2 and EXP3. For example, Table 2 shows that EXP1 always performs best with regard to the correlation coefficient, in 7 (8) cases out of 12 with regard to the normalised StdDev (Bias%), and in half of the cases with regard to RMSE. Likewise, it performs always best (regardless of metric) for phosphate and nitrate, and in half of the cases with regard to chlorophyll. Even if some differences to EXP2 and EXP3 are only small, I think this could be discussed a bit more (so far, there seems only be a sentence in line 451), and contrasted with the outcome presented in Tables 4 and 5, which indicate that EXP3 performs best with regard to surface Chl a. What is the reason for these differences? Is it because Table 4 and 5 only refer to surface values?

Specific comments:

Line 36: Here I would prefer a more specific link to a model application at copernicus (I had to search around a bit).

Line 49: "introduces"

Line 60f: "(...) therefore there is already some zooplankton biomass present at the time of the start of spring." - Only if they ascend early enough, correct? perhaps add: "... and ascend to the surface at the onset of spring"?

Line 65: "Glacialis" should be lower case

Line 71: "description"

Line 89: "use the time stepping" - What time step lengths were applied?

Line 103: "matters" - Perhaps better: "components"?

Line 105: "discrete nutrients" - What are "discrete nutrients"? Skip "discrete"?

Line 105: " the a" - skip "the"

Eqn 1: Number seems to be missing.

Eqn 2: please show how phi is calculated

Line 172: Evaluation after just two years of spinup seems to be quite soon - do you have any indication if the model drift (with regard to the BGC components) has decreased to some specific value?

Line 188: better: "parameter sets" (?)

Lines 197 and 199: "GOTM": Please explain and reference the abbreviation before it is used first.

Line 201: ""from Station-M is" - "are"

Line 201-202: "The dynamics shown in Appendix A1 is expected to be valid for each model point." - How is this expectation justified?

Line 211: "for model assessment is" - "are"

Line 214 "the model's use as a tool" - perhaps better: "the model as a tool"?

Line 220-221: "Nitrate, silicate, phosphate and chlorophyll a in situ data from Institute of Marine Research (2018) were used for the statistical evaluation of the model results." Where were these data used and what is the difference to the comparison against WOA2013 data?

Line 226: "were used for evaluation" - of simulated Chl a?

Line 229 "Processed model chlorophyll" - What does "processed" mean in this context?

Line 230: "OC-CCI chlorophyll a" - I can guess what this is, but provide the abbreviation above, when citing Sathyendrant et al.

Figure 3 caption and elsewhere: "WOA18" - above you refer to WOA2013

Figure 3 caption: "EXP1: solid ..." - But in the figure the different experiments are indicated by different colours.

Line 278: "0.6-0.72" - Table 2 gives 0.79-0.83 for EXP1: confusion with EXP3?

Line 279ff: For the biases Table 2 gives the relative bias, but in the text you refer to absolute biases, which is somewhat confusing.

Line 280: "2.47-3.34" - this seems to be the bias of EXP3.

Line 285: skip one "Fig."

Line 290: "0.74-0.78" - again, for EXP3?

Line 292: "modeled upper 100 m maximum" - please rephrase

Line 296: "The model code" - this sounds as if the model does it all by itself, I would rephrase this e.g. to "in the model uptake of silicate is limited to concentrations above"

Line 300: "0.81-0.89" - again EXP3?

Line 311: "0.97-1.2" - EXP3?

Line 315: perhaps better: "chlorophyll a is always below 8mg ..."

Line 383-383: "silicate concentrations ... in the climatological data." - are discharge rates into the Arctic very different for different types of nutrients? (I.e., outside the assumed stoichiometry)? Perhaps a note on this would be interesting ...

Line 425: "EXP1 is the least representative of the in situ data" - of Chl a, I assume? Because Table suggests that EXP1 represents in situ data of nutrients best.

Lines 443-446: It is not really clear to me what you want to say with this sentence - could it be rephrased?

Line 447: "overestimate" - perhaps better: "... curve leads to an overestimate of the bloom"?

Line 451: "EXPeriment statistics for inorganic nutrients are very similar in all experiments (Table 2)." - Overall, to me it seems as if EXP1 performs better than EXP2 and EXP3 (see above my comment no. (4))

Lines 478-479: "using realistic ... spin-up period" - what are the realistic constant values? and: constant with respect to what - over time? over depth?