

Interactive comment on “Sensitivity of phytoplankton distributions to vertical mixing along a North Atlantic transect” by L. Hahn-Woernle et al.

Anonymous Referee #1

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General Comments

The manuscript investigates the sensitivity of vertical distributions of chlorophyll in the upper ocean to observations of vertical turbulent mixing. The approach of using observed vertical profiles of turbulent mixing to study its impact on development of deep chlorophyll maxima or upper chlorophyll maxima is an interesting approach and scientifically valuable. The topic fits well into the scope of Ocean Science. However, the introduction of the manuscript fails in giving a good motivation and the conclusions are stated too vaguely. The methodology is not very clear, the simulations seem to be too short and unfortunately the presentation of the scientifically new part of the manuscript

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is too short. The figures are also not well arranged. Since the general idea of the manuscript is very interesting and the results show interesting trends, I recommend major revisions before publishing the manuscript in OS.

Specific Comments

1. p. 840, l. 16-p. 841 l. 2: The first paragraph of the introduction is a summary of studies that is not necessary for the manuscript. Instead, give a motivation by indicating why the vertical structure of chlorophyll could be important (e.g. implications for satellite observations and the biological pump).
2. p. 848, l. 19: Why it is important that the PGM is a non-local model? Omit sentence or explain.
3. p. 849, l. 6: "Initialized" gives the impression I_{in} would vary with time, but apparently it is kept constant during the simulation. Maybe use "set".
4. p. 849, l. 10: What are the values of N_b based on?
5. p. 849, l. 13: A timestep of 24 h seems very long in comparison to the shortest time scales of the model. Do the results change with a smaller time step?
6. p. 849, l. 23: Since the forcing is constant, the model is not able to represent any transient processes and should therefore run to full equilibrium. Consider omitting second part of the sentence and run the model to full equilibrium.
7. p. 850, l. 3: Not clear. When is the model reaching an oscillatory solution? Always with low vertical mixing? Also in the simulations in this manuscript?
8. p. 850, l. 8: What is the difference between the model configuration in the manuscript and the model configuration of Ryabov et al. (2010)?

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9. p. 850, l. 17: It is obvious that the values of the biological parameters affect growth. Omit sentence.
10. p. 850, l. 18-26: Why does the model only represent a single species? The parameters could be optimized so that it represents a functional group or phytoplankton community. It is obvious that the simplicity of the model itself requires the optimization of the parameters. Consider omitting from line 18, "Many.." to line 26, "measured data".
11. p. 851, l. 20: The reader doesn't know what the irradiance is corrected for until reading the appendix. Refer to the appendix when writing about the corrected irradiance.
12. p. 852, l. 14: No range is given, just a number. Replace "range" by "of around"
13. p. 852, l. 16: Not clear. Probably "explicitly" is meant instead of "implicitly"?
14. p. 853, l. 13: Repetition. Omit sentence.
15. p. 853, l. 14: Why are not all data points used for the calibration? Using the criteria recedes the information used for the parameter optimization. Explain or test if results change when all concentrations are used for the parameter optimization.
16. p. 854, l. 1. p. 855, l. 1, ..: The list of the meaning of lines in the main text is not necessary and distracting while reading the manuscript, the explanation in the figure captions is enough.
17. p. 854, l. 14: If the plot is based on the crosses, it seems like S is extrapolated rather than only interpolated and values away from the crosses are highly uncertain. This plot could be left out.

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18. p. 855, l. 22: Explain the consequences and reasons for the different values of S or omit sentence ("Note that, .."). The reader is left wondering why S is so different.
19. p. 856, l. 13: Why is the suite of parameter values tested different for the different stations? A more consistent and informative analysis would have been to use the same. Explain or perform a more consistent sensitivity analysis.
20. p. 856, l. 26: If a simulation is not in steady state with the best parameter set, consider to run the model longer for all experiments or define a steady state definition that is reached in each simulation.
21. p. 858, l. 13: Clarify how the assumption that the total phytoplankton growth is idealized as one species is influencing the choice of k . I suggest taking the mean of the determined values is a consistent approach and doesn't need extra motivation.
22. p. 858, l. 25 - p. 860, l. 12: Why should vertical mixing not play a role in the equilibrium? Maybe it does not in the mixed layer since nutrients are homogeneously distributed but at the depth of the DCM vertical mixing should be crucial due to the gradients of nutrients. The whole section about equation 7 seems redundant because no additional conclusions can be drawn and validity of the equation is questionable. I suggest omitting the section (p. 858, l. 25 - p. 860, l. 12). More interesting are the sensitivity analyses to boundary condition N_b and forcing I_{in} that follow.
23. p. 862, l. 4-5, p. 862 l. 19-20: Move plot description to figure caption.
24. p. 865-866, How are the results of Ryabov et al. (2010) connected to the results in this manuscript? What is the integrated conclusion from both results?

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25. p. 865-866: The interesting question of what the role of the shape of the vertical mixing profile is, is left unanswered. Can a mechanism or general pattern be drawn from the results? The manuscript would largely benefit.
26. p. 866, l. 14-20: It is very unfortunate to leave this as the last sentences for the reader. The possibility to infer vertical mixing from chlorophyll distributions could theoretically be possible but the results are not sufficient to show this. The indications of the results on this possibility should not be mentioned at this prominent place at the end of the manuscript and not in this negative way but could rather be mentioned as a side-note.
27. All Figures: Use actual superscript instead of m3 or m2. For better readability move multiplier to the units instead of the multiplier at the axis, e.g. in figure 5, write [10^8 cells / m^3] instead of 10^8 at the axis. Whenever applicable use unit prefixes, kilo, mega, giga, etc. Move the plot descriptions (e.g. top: spring, bottom:summer) to the figure caption.
28. Figure 5, 7a, 8a: In the right panel: Move x axis label to the ticks at the bottom. Consider arranging these plots together in one figure with three plots for better comparability.
29. Figure 6a: If the purpose of the plot is only to show the complexity of the calibration it could be left out because the complexity itself is not an interesting result and does not help to understand the other results.
30. Figure 6b, 7b, 8b: Extend legend by HI: and HN: for better readability. Consider arranging these plots together in one figure with three plots for better comparability.
31. Figure 9b, 10b: Plot growth limiting factors together in one plot for better comparability.

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