

Biogeosciences Discuss., referee comment RC2
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Comment on bg-2021-97

Anonymous Referee #2

Referee comment on "Deep chlorophyll maximum and nutricline in the Mediterranean Sea: emerging properties from a multi-platform assimilated biogeochemical model experiment" by Anna Teruzzi et al., Biogeosciences Discuss., <https://doi.org/10.5194/bg-2021-97-RC2>, 2021

Review of "Deep chlorophyll maximum and nutricline in the Mediterranean Sea: emerging properties from a multi-platform assimilated biogeochemical model experiment" by Teruzzi et al.

The manuscript addresses the performance of a 3D-Var biogeochemical data assimilation system, constrained with both chlorophyll data from satellite and chlorophyll and nitrate data from BGC-Argo floats, that is applied to a realistic simulation of the Mediterranean Sea for the year 2015. After demonstrating the validity of the method, the authors use their product to investigate the spatial and seasonal variability in the vertical structure of chlorophyll and nitrate fields. The problem is introduced clearly, methodology appears sound, and results are compelling. I recommend the manuscript for publication in Biogeosciences after revisions. Below are a couple of important results that need to be clarified, a list of issues to be addressed, and some minor comments.

1) Fig 2: With the exception of the "LEV" region, it seems that assimilating only float data yields a better fit with chl obs than assimilating floats + satellite. It seems like it would be best to ignore satellite data, even at the surface. On the other hand (Fig 3), assimilating satellite Chl yields a better fit with nitrate obs, which is counter intuitive, and assimilating float Chl barely has an impact. Please comment!

2) L. 242-244, 260-261: In Fig 4 I don't see a reduction in RMSD, but instead an increase in levels 4-6. So data assimilation does reduce the model skill in fitting oxygen? It looks like the pink and red curves are on top of each other, suggesting that satellite Chl is responsible for degrading the O2 solution.

Other comments:

3) Abstract and L. 68: is "semi-independent data" a common way to refer to observations used in model-data comparisons before and after assimilation? I suggest changing "semi-independent data (before assimilation)" to "assimilated data (before and after assimilation)".

4) When data is excluded from assimilation based on a DA criterion, as stated in L. 98-100, is that a "quality check" on the data? Or is it removing observations that can't be fit because of model inadequacies? Is there a reference for the threshold values (5 mg/m³ for Chl and 1 or 2 mmol/m³ for NO₃)? Similarly on L. 87-88 "A further quality check on satellite values before the assimilation resulted in the exclusion satellite chlorophyll observations whose mismatch value with respect to the model was higher than 10 mg m⁻³." - Is this a check of the quality of the data or a DA-based exclusion criterion?

5) L. 96-97: "chlorophyll profiles were checked for negative values (rejection)" - I imagine that a bias correction is applied to the Chl data, resulting in sometimes negative values at some depths. Does that necessarily mean the profile can't be used? Maybe negative values could be viewed as "zero"?

6) L. 115-116: "3DVarBio is the data assimilation scheme for the correction of phytoplankton functional type and nutrient variables (i.e., nitrate and phosphate)" - It sounds like phytoplankton type is a control variable, which to me suggests that the type can be changed by assimilation. However, I believe you mean that the biomass in each phytoplankton class can be optimized. It would be useful to know how many functional types there are (it's mentioned later, but at this point I was wondering). Also, this is one of a few places where phosphate is mentioned. Why control phosphate and not other bgc variables, like oxygen? Does the model include other nutrients?

7) Section 2.2 is hard to follow, with so many models and acronyms. I would start by describing MedBFM, then OGSTM and BFM, then 3DVarBio. What does it mean that the transport model is "fully consistent with the off-line coupling of the NEMO3.6 vvl"? On L. 135 the "MENO3.4-OceanVar model" is mentioned: should it be NEMO? If so, why mention NEMO3.6 earlier when you're using version 3.4?

8) L. 141-145: What does it mean for climatological profiles to "integrate" data? Is it different from initializing a model from data and spinning it up for a couple years? What is a "Newtonian dumping term"?

9) L. 145: Tracer concentrations need to be relaxed to climatology even though the simulation is only 1-year long? Is that typical for the Med Sea?

10) Comment on the fact that RMSD increases at the surface in TYR when only satellite chlorophyll is assimilated?

11) L. 281: What is the significance of the 0.3 value?

12) Fig 7: Why does the y-axis stop at 300m? There is a large change at 300m in summer, TYR. Caption: "5 left panels" should be "5 right panels". It would be helpful to label figures panels "a", "b", "c", etc. Why are some panels empty?

13) L. 429-430: The results are consistent with previous studies. Can you elaborate on whether the results are quantitatively different? Or do they simply agree with previously known features of the Med Sea?

Minor comments:

- L. 84-86: "Original products [...] were reviewed for spikes excluding observations whose anomalies were higher than 3 times the daily climatology standard deviation" - The sentence is not clear. Maybe rephrase to "In the original products [...] observations whose anomalies were higher than 3 times the daily climatology standard deviation were excluded in order to remove spikes".

- L. 122-123: Is it only the optical model this is not included in the present application (but the other 2 are)? Why isn't it included?

- Fig 2: The gray lines hard to see; I suggest removing other grid lines.

- L. 286 p5th = 95th?

- L. 384-385: "Maintaining the diagonal the observation error covariance matrix" - remove second "the"?

- L. 393: "Thus, while it is desirable an increase of nitrate sensors number" - should be

“while it is desirable to increase the number of nitrate sensors”?

- The Verdy and Mazloff reference is missing from the bibliography.