Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2018-423-AC1, 2018

Biogeosciences Discussions

Interactive comment on "The Mediterranean subsurface phytoplankton dynamics and their impact on Mediterranean bioregions" *by* Julien Palmiéri et al.

Julien Palmiéri et al.

julien.palmieri@noc.soton.ac.uk

Received and published: 24 November 2018

Although the referee #1 appreciates the analyses, the idea, and the importance of the subject discussed in the paper, he/she doesn't think the model used is appropriate for this study. Mainly the chlorophyll performances are thought to be too poor for this analysis, and the NEMO model is maybe not appropriate to model the Mediterranean sea. We will discuss this in the following paragraphs, and try to convince that even though the model chlorophyll has imperfections, we think it is appropriate to perform our analysis. Our study provides interesting analysis on the classification of the bioregions in the Mediterranean basin, which we think are useful to provide to our scientific community.

* About NEMO in the Mediterranean Sea.

Modelling the Mediterranean Sea circulation requests a high resolution model with adapted atmospheric forcing that includes its surrounding topography, to get the right winds that will induce specific eddies and deep water mass formation. It is not an easy task, especially without any kind of data assimilation or surface relaxation, and still the NEMO-MED12 configuration manage to model probably the best (whole) Mediterranean circulation. It includes specific events like the Eastern and Western Mediterranean Transient, and is probably the most evaluated regional circulation configuration, with not only dynamic evaluation (Temperature, Salinity), but also transient passive tracer that track the sea interior ventilation (CFC, tritium, . . ., see Palmiéri et al. (2015), Ayache et al. (2015), Ayache et al. (2016)).

Of course It is not perfect, no model is, but because it is well evaluated, we managed to highlight the model strengths and weaknesses, document the improvements between each version (better intermediate water ventilation when improving the atmospheric forcing, better deep water circulation when changing from 50 to 75 vertical levels, ...), and it helps understanding the model circulation impact on the biogeochemistry (this is unique in the Mediterranean modelling community).

So, we can discuss how appropriate NEMO is to model the Mediterranean sea, but we should also admit that the teams behind these NEMO-MED configurations are doing a good and healthy job, and obtain nice results.

* About our modelled chlorophyll.

- Pisces is a biogeochemical model. We mainly focussed the discussion on the chlorophyll for our analysis, but we should not forget all the other variables modelled, that are reasonably correct (See Fig. A2 for nutrients, and Fig. 1 for surface Chl), so that it is appropriated to conduct interesting biogeochemical studies. Our model results are sensible, it captures the main features of the Mediterranean sea, and other biogeochemical models are doing similar jobs (Lazzari et al. (2012), Mattia et al. (2013),

Guyennon et al. (2015), Macias et al. (2014)). If you look all these other Mediterranean modelling studies, we do evaluate our model performances much more than it is usually done. This is because we think it is good practice to not skip or hide the model weaknesses, but rather to show and discuss them: 1- To help finding the origin of the problems, we share the informations so that we can discuss solutions with other groups, 2- Because it gives a good overview, a better understanding of our model to the reader, and we think it is important. So yes, the model chlorophyll does not perfectly match the observations, and you know why it could be so. Moreover, a similar version of the NEMO/PISCES model, not perfect as well, has already been used for published biogeochemical investigation in the Mediterranean basin (Richon et al, 2018a,b)

- We especially used BGC-Argo observations (We are probably the first modelling group to evaluate our model with these data) to show that surface, max and total chlorophyll patterns found in the model are present in observations. This is a key point. I would agree that we could not easily believe the model integrated chlorophyll phenology and derived bioregions only based on the vertical profile comparisons (Fig. 4). But the vertically-integrated chlorophyll phenologies from the BGC-Argo show similar patterns (Fig. 11), with the winter and the summer chlorophyll maxima! And this (maybe we should make it clearer in the text) demonstrates that even if the model chlorophyll has weaknesses, our analysis is sensible, and the conclusions drawn from it actually make sense. A model will never be perfect in all aspects, and it is so regrettable to be penalized because we provide more evaluation than usually performed.

Finally, as the referee said, “the topic is highly relevant”. We strongly think that our conclusions drawn from the model and supported by observations are realistic, and we are convinced it is an interesting study that should be useful to the wider community.

References:

Ayache, M., Dutay, J.-C., Jean-Baptiste, P., Beranger, K., Arsouze, T., Beuvier, J., Palmieri, J., Le-vu, B., and Roether, W.: Modelling of the anthropogenic tritium tran-

sient and its decay product helium-3 in the Mediterranean Sea using a high-resolution regional model, Ocean Science, 11, 323–342, https://doi.org/10.5194/os-11-323-2015, 2015

Ayache, M., Dutay, J.-C., Arsouze, T., Révillon, S., Beuvier, J., and Jeandel, C.: High-resolution neodymium characterization along the Mediterranean margins and modelling of εNd distribution in the Mediterranean basins, Biogeosciences, 13, 5259–5276, https://doi.org/10.5194/bg-13-5259-2016, https://www.biogeosciences.net/13/5259/2016/, 2016.

Guyennon, A., Baklouti, M., Diaz, F., Palmieri, J., Beuvier, J., Lebaupin-Brossier, C., Arsouze, T., Béranger, K., Dutay, J.-C., and Moutin, T.: New insights into the organic carbon export in the Mediterranean Sea from 3-D modeling, Biogeosciences, 12, 7025–7046, https://doi.org/10.5194/bg-12-7025-2015, 2015.

Lazzari, P., Solidoro, C., Ibello, V., Salon, S., Teruzzi, A., Béranger, K., Colella, S., and Crise, A.: Seasonal and interannual variability of plankton chlorophyll and primary production in the Mediterranean Sea : a modelling approach, Biogeosciences Discussions, 9(1), 217–233, DOI: 10.5194/bg–9–217–2012, 2012

Macías, D., Stips, A., and Garcia-Gorriz, E.: The relevance of deep chlorophyll maximum in the open Mediterranean Sea evaluated through 3D hydrodynamic-biogeochemical coupled simulations, Ecological Modelling, 281, 26–37, 2014.

Mattia, G., M. Zavatarelli, M. Vichi, and P. Oddo, The Eastern Mediterranean Sea biogeochemical dynamics in the 1990s: A numerical study, J. Geophys. Res. Oceans, 118, 2231–2248, doi:10.1002/jgrc.20160, 2013

Palmiéri, J., Orr, J. C., Dutay, J.-C., Béranger, K., Schneider, A., Beuvier, J., and Somot, S.: Simulated anthropogenic CO2 storage and acidification of the Mediterranean Sea, Biogeosciences, 12, 781–802, https://doi.org/10.5194/bg-12-781-2015, http://www.biogeosciences.net/12/781/2015/, 2015.

Richon C., J-C Dutay, F Dulac, R Wang, and Y Balkanski, Modeling the biogeochemical impact of atmospheric phosphate deposition from desert dust and combustion sources to the Mediterranean Sea, Biogeosciences, 15, 2499–2524, 2018

Richon C, J-C Dutay J-C, F. Dulac, P. Nabat, R. Wang, Y. Balkanski, O. Aumont, C. Guieu, K. Desboeufs, B. Laurent, P. Raimbault, and J. Beuvier, Modeling atmospheric deposition impacts on major nutrients and biological budgets of the Mediterranean Sea, 2018„ Progress in Oceanography,163, 21-39, , doi.org/10.5194/bg-15-2499-2018

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2018-423, 2018.