Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2020-210-RC1, 2020

Biogeosciences
Discussions

Interactive comment on "Warmer winter causes deepening and intensification of summer subsurface bloom in the Black Sea: the role of convection and self-shading mechanism" *by* Elena A. Kubryakova and Arseny A. Kubryakov

Anonymous Referee #1

Received and published: 10 July 2020

Review on manuscript: BG-2020-210 entitled: "Warmer winter causes deepening and intensification of summer subsurface bloom in th Black Sea: the role of convection and self-shading mechanism"

Authors present 2-years time-series data from two Bio-Argo floats measuring temperature, salinity, Chl-a flurescence and irradiance in the Black Sea. They observed differences in deep chlorophyll maximum depth and intensity between summer 2016 and 2017. In 2016, DCM was deeper with lower maximum Chl-a concentration than in 2017. Authors explained these differences by previous winter conditions. Authors ar-

gue that if more nutrients are supplied in surface waters during winter, they can sustain during the whole summer period via remineralisation an higher phytoplankton biomass and a shallower DCM. This paper is interesting because it raises questions about which factors control DCM. As DCM results from an equilibrium between light (impacted by phytoplankton itself) and nutrients, determining which factor determines its position and intensity remain a challenging question. However, the authors presented a theory without giving the strong proofs and arguments. In fact although they claimed in the conclusion that they have showed that "the intensity of winter convection largely controls the bio-productivity and the position of the deep maximum Chl throughout the year", no strong differences is observed in Mixed Layer Depth (MLD) between 2016 (40m) and 2017 (45m), no data are provided about nutrient distribution. Finally, the impact of small scale structures such as fronts, eddies, etc. which are known to impact the nutrient vertical distribution and the DCM are ignored although the Argo floats trajectories indicates the presence of eddies or small gyres. Then, I recommend to reject this manuscript as it is.

However, given the value of the Bio-Argo dataset in this region and the interest of the scientific community about DCM, I would recommend to the authors to resubmit later their manuscript after major modifications and improvements. I advise to the author to add information about nutrients distribution in the Black Sea, to deeply reconsider the theory which are presented in this paper and to support any new theory with arguments and data. I also suggest to the authors to avoid the monthly averaging of the data. By this way small scale events can be considered. In addition, I would like authors investigate what happens in June 2017 when DCM unexpectedly uplifts.

Specific comments:

Introduction:

line 21-22, winter phytoplankton remineralisation needs reference. Same nutrients sustain spring bloom and summer DCM? You need to reference and argument.

line 25: Strong?

Line 29: “winter severity” is too general.

Line 32: DCM in Black Sea, please provide more details

Lines 39-43: photo-adaptation and photo-inhibition mechanisms need to be better described.

Line 56: Please replace the term “winter convection” by “winter mixing”. Convection implies very deep mixed layers and specific mechanisms.

A presentation of the Back Sea with water mass presentation and circulation, nutrient and phytoplankton distribution is missing.

Data and Method:

Lines:62-63 please give details and show data. Regading Chl-a concentration data. How did you treat non photochemical quenching?

Line 74: Can you better justified your 0.07 kg/m3 criteria for MLD calculation. The criteria 0.03 or 0.05 kg/m3 are more commonly used. With a criteria of 0.07, MLD may be overestimated.

Results:

Lines 79-86: this paragraph should be in the introduction. Please provide concentration values for nitrate and phosphate in the Black Sea.

Line 93: “Convection” should be replaced by “mixing”

Line 94: what is the “cold intermediate layer”?

Figure 2: Please use a continuous color palette. These discontinuous colours can artificially emphasis differences in two situations which may be not so different (opposition between red and yellow colors).

Line 108: Without any data on nutrients concentration how can you argue that there is an entrainment of nutrients?

Figure 4: Can you explain the Chl-a increase in August 2016 and the DCM uplift in June 2017? Line 118-120: Please provide evidence to support this statement: “Thus, intense entrainmentof nutrients in the winter of 2017 led to an increase in biological productivity not only in winter but also in the following months as a result of their remineralization.” Figure 5: Is this figure necessary?

Discussion

line 182: Indicate to which isopycnal nitracline is related and draw it on Figure 2.

line 185 : “Further thermal stratification stabilizes the water column but keeps the same concentration of nutrients”, nutrients are generally rapidly consumed, data are needed to support this statement.

Line 188: Hypothesis on regeneration need to be support by strong data. In fact, regeneration generally happens in depth due to particles sedimentation.

Figure 7: This figure and the associated conclusions should be removed or at least deeply reviewed. Regarding the figure itself, it is very surprising to see a Chl-a DCM shape inside the mixed layer. In the mixed layer, one can expect homogeneous Chl-a profiles. Authors should have mentioned at least: “winter MLD” and “summer Chl-a vertical profile”. Instead of the PAR arrows, it would be more accurate to indicate the position of isolumes as this information is available from Bio-Argo data. Regarding the theory explained in figure caption, I don’t think the data presented in this paper allow to support it. Although authors didn’t support with nutrient data the statement “In a cold winter, the larger amount of nutrients (grey color) is convectively entrained in the upper layer”, my maine concern is for the following statement about case (b) : “In the summer period with increase of PAR, light penetrates the upper layer of nitroclyne and causes intense and deep summer subsurface bloom. Therefore, the total amount of nutrients

used by the phytoplankton in both year is comparable." In fact, summer light increase happens in both years and as soon as surface nutrients are consumed, DCM forms and deepens. It seems impossible that DCM production in oligotrophic conditions can compensate additional winter production permitted by extra nutrients inputs in surface waters. In addition, authors should remind that deep DCM have generally an higher Chl-a/biomass ratio than shallower DCM as Chl-a per cell increases to compensate the decreasing of light.

Line 200-207. Hypothesis on self-shading due to higher winter Chl-a concentration for explaining shallower DCM during the full summer season is doubtful. In fact, what which have been observed before is that as soon as bloom ends, DCM set up and deepens due to lower nutrient availability and higher light availability.

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2020-210, 2020.