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Interactive comment on "Warmer winters causes an increase of chlorophyll-a concentration in deeper layers: the opposite role of convection and self-shading on the example of the Black Sea" *by* Elena A. Kubryakova and Arseny A. Kubryakov

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Kubryakova and Kubryakov analyzed in situ data from two biogeochemical-Argo floats deployed in the Black Sea. They were interested in how the winter season could influence the phytoplankton biomass (vertical distribution and concentration) for the rest of the year. For this, they focused on observed differences between two years: 2016 and 2017.

Their manuscript is based on the spatiotemporal variabilities of several measured pa-

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rameters: temperature, salinity, chlorophyll-a concentration and downwelling irradiance. In 2016, the winter season was warmer and associated with a lower vertical mixing than in 2017. The phytoplankton spring bloom intensity was lower in 2016 (lower chlorophyll-a concentration) than in 2017. In summer 2016, the Deep Chlorophyll Maximum (DCM) was deeper than in 2017. Authors suggested that in the Black Sea, a warm winter reduces the nutrient availability for the whole year, which decreases the phytoplankton spring bloom intensity and reduces the light attenuation in summer because of lower concentrations in phytoplankton cells and dissolved organic matter.

Such detailed study of physical-biogeochemical variables in the Black Sea based on in situ data is original and could greatly contribute to increase our understanding of physical-biological processes in this basin. However, some authors' assumptions are questionable and I have several specific comments. Therefore, the paper will likely be a significant scientific contribution with major revisions.

Major comments:

1) Authors wrote several times in the manuscript that in the Black Sea, as in other oligotrophic basins, the nitracline is closely connected to an isopycnal (for examples, see lines 80, 156, 161 and 287). When looking at figure 2 c-d, we can clearly see that isopynals between 1014 kg/m3 and 1014.4 kg/m3 (associated with the nitracline, see line 158 and figure S1) are shallower in summer 2017 than in summer 2016. Therefore, in summer 2017 the nitracline (or nutricline) is shallower than in summer 2016. The low chlorophyll-a concentration in 2017 between 40-60 m is probably due to a change in in the depth of isopycnals and not to a "rise of light attenuation", as argued by authors (line 387).

Line 343 – "The closeness of DCM and nutricline increases the nutrient fluxes in the summer of the years with warm winter, which compensates for their decrease in winter caused by weak convective entrainment". Such statement is false, because authors did not discuss differences in the depth of the nutricline between summer 2016 and

summer 2017.

In addition, when looking at figures 4a-b, chlorophyll-a concentration at the DCM is higher in 2017 than in 2016. Considering that isopycnals were shallower in 2017 than in 2016, and based on figures 4e-f, one could argue that the light level at the nutricline is higher in 2017 than in 2016. A higher light level at the nutricline could induce a higher phytoplankton production and biomass in the DCM, as observed in 2017. Such mechanism, clearly explained in the comprehensive review of Cullen (2015), is crucial and need to be discussed.

2) When studying DCM, it is important to know if the DCM is also a subsurface phytoplankton biomass maximum. Because, changes in chlorophyll-a concentration at a DCM could be induced by variations in intracellular chlorophyll-a concentration or by changes in phytoplankton biomass. In the current version of the manuscript, this point is not discussed.

When using data from biogeochemical-Argo floats equipped with an ECO Triplet (as here, line 110), measurements of particulate backscattering coefficient (bbp), a proxy of the particulate organic carbon, are available. These measurements have been used in a paper published by one of the authors (Kubryako et al., 2019). The manuscript will be more comprehensive if those measurements could be added to the current analysis.

Minor comments:

Line 11 – “caused an increase of Chl in winter up to 0.6-0.7 mg/m3 compared to a warm winter of 2016”: It is unclear. There is an increase of Chl in winter in both years.

Line 19 – “more productive”. That is a suggestion. Chlorophyll-a concentration measurements are not primary production estimates.

Line 24 – “With the rise of stratification and irradiance vertically. . .” A comma is needed after the word “irradiance”.

Line 26 – “After the bloom, part of the nutrients. . .fuel the phytoplankton bloom”. How

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many blooms are there in a year?

Line 27 – “nitroclyne”. It is a wrong spelling, used several times in the manuscript. Need to be replaced everywhere by “nitracline” or “nutricline”. However, here it could be replaced by “euphotic zone”.

Line 31 – “. . .convection in the Black Sea, impact on the. . .”. Need to be replaced by “. . .convection in the Black Sea impacts on the. . .”

Line 35 – replace “biomodelling” by “modelling”

Line 45 – The diapycnal diffusivity could be an important physical process for nutrient supply. Maybe it is the most important in summer.

Line 52 – The relationship between expressions: “high values of irradiance may cause photoinhibition”, “photoadaptation” and “increase of Chl content per cell” is unclear.

Line 66 – Replace “Bio-Argo buoys” by “biogeochemical-Argo floats”. Throughout the manuscript, the word “buoys” should be replaced by “floats”.

Line 89 – “Long-term rise of temperature observed globally (Behrenfeld et al., 2016)” This study did not focus on the long-term rise of temperature.

Line 121 – “ðİŘ¿ðİŚŚ (λ)” The letter z is missing in the parentheses.

Line 124 – All measurements from Argo floats have quality control flag values. Did authors check them?

Line 125 – Information about the process to obtain potential density values from in situ temperature and salinity measurements are missing.

Figure 2 – Is it in situ or potential temperature? Potential density? The colorscale or isolines are inconsistent. For example, in panel C, the isopycnal 1014.2 has a yellow background and in the panel D has an orange background.

Here and throughout the manuscript, could the authors use another colormap, not a

rainbow one: “In the 2007 IEEE article, Rainbow Color Map (Still) Considered Harmful, authors David Borland and Russell M. Taylor II from the University of North Carolina at Chapel Hill stated, “The rainbow color map confuses viewers through its lack of perceptual ordering, obscures data through its uncontrolled luminance variation, and actively misleads interpretation through the introduction of non-data-dependent gradients.”

Line 154 – “conventional mixing”, is it the right term?

Section 3.1, Figure 2 and Figure 3 – Regarding physical parameters, there are no information or comments about potential differences between the two floats for a same year due to differences in their geographical locations. Are there any differences in the vertical distribution of temperature, isopycnals and MLD between the two floats for a same year? In addition, time series of temperature and density for each float should be added in supplementary materials. The sentence, line 101: “As we will show below, despite these differences in the geographical position both buoys show similar results concerning the paper topic” needs to be supported by figures and values for all physical and bio-optical parameters used here.

Line 201 – “productivity” chlorophyll-a concentration is a proxy for phytoplankton biomass not phytoplankton production.

Line 256 to 259 – This is a suggestion, it should be discussed in the discussion section.

Figure 7 – Why yearly-averaged profiles and not only summer (and winter) profiles.

Line 267 and figure 3b – It would be better to describe time series of depth integrated chlorophyll-a concentration and not column-averaged.

Line 274 to 276 – This is a suggestion, it should be discussed in the discussion section.

Line 308 – “the euphotic layer deepens, and the surface layer becomes over-illuminated” It would be better to use the euphotic depth definition. What is the meaning of “over-illuminated”?

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