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The chlorophyll seasonal dynamics in the Black Sea as inferred from Biogeochemical-Argo floats

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Biogeochemical-Argo (BGC-Argo) floats offer the opportunity to investigate the spatial and temporal dynamics of chlorophyll a (Chla) profiles. In the Black Sea, the unusual abundance of colored dissolved organic matter (CDOM) and the absence of oxygen below ∼80-100m require a revision of the classic formulation used to link the fluorescence signal and the algal chlorophyll concentration (e.g. Xing et al., 2017). Indeed, the very high content of CDOM in the basin is thought to be responsible for the apparent increase of Chla concentrations at depth, where it should be zero due to the absence of light. Here, the classic formulation to link fluorescence and Chla is revised based on a reference Chla dataset sampled during a scientific cruise onboard RV Akademik and analysed with High Performance Liquid Chromatography (HPLC). Then, using the established equation to remove the contribution of CDOM to the fluorescence signal, we estimated the Chla profiles from 4 BGC-Argo floats during the period 2014-2017. All Chla profiles were thus highly quality controlled by using the Argo documentation (Schmechtig et al., 2015). Especially, we removed bad data (e.g. spikes, outliers) and we corrected the Non-Photochemical Quenching effect, a photoprotective mechanism resulting in a decrease in the fluorescence signal at the surface.

The Chla profiles are categorized based on fitting algorithms (e.g. sigmoid, exponential, gaussian) and empirical criteria. They display a large variety of shapes across the seasons (e.g. homogeneity in the mixed layer, subsurface maximum, double peaks below the surface, etc.) with roughly homogeneous profiles dominating between November and February while subsurface maxima are present during the rest of the year, with in summer a clearly-marked deep chlorophyll maximum (DCM).

We then investigate the formation mechanism of DCMs based on the hysteresis hypothesis for the temperate ocean proposed by Navarro et al., (2013). For this, we looked at the correlation between the position of DCMs and the potential density anomaly of the mixed layer when it is maximum in winter, usually between February and March. We show that DCMs are highly correlated with the potential density anomaly of the previous winter mixed layer where a winter bloom initiated while the correlation with the 10% and 1% light levels is poor. This is in agreement with the hysteresis hypothesis that assumes that in regions where a bloom forms in late winter/early spring, this bloom remains established at a fixed density (i.e. the density of the mixed layer when it is maximum) until the end of summer acting as a barrier for the diffusion of nutrients from below and preventing the occurrence of deeper blooms due to a shading effect. This bloom is finally progressively eroded in autumn, when the depth of the mixed layer increases again.