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Downward biogenic fluxes in the SW Black Sea: dynamics of their compositional and temporal patterns

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In the Black Sea, downward fluxes of biogenic elements in the water column were monitored during a 1 yr (2007-2008) sediment trap deployment in the SW basin (at 1000 and 2000 m water depth) aiming at appraising their amplitude, seasonal variability and prime controlling factors, and thus better assessing the biogeochemical functioning of this environment.

Particulate organic carbon (POC) and carbonate fluxes display a strong seasonal pattern, with peak values in late autumn (POC) and early summer (carbonates). Mean POC fluxes at 1000 and 2000 m were 11.3 and 6 mg/m2/d, respectively, corresponding to 1.8 and 1 % of the estimated primary production. We used source-specific lipid biomarkers in order to determine the major phytoplankton contributors to the biogenic fluxes, as well as terrestrial organic inputs, and to shed light into the composition and variability of the biological system. These molecular data clearly demonstrate that diatoms (in particular Rhizosolenia species) are foremost drivers of the peak POC flux in late autumn. As expected, diatom productivity is also closely related with the patterns of the export opal fluxes. Furthermore, biomarkers document a major bloom of Emiliania Huxleyi in late spring/early summer, likely sustained by riverine nutrient inputs and/or regenerated nutrients. However, POC export is less strong during the coccolithophorid bloom. In contract, this bloom controls the unique peak value of carbonate flux. Dinoflagellate-specific biomarkers reveal a less prominent seasonal pattern, with higher values in late autumn and summer. In all the aforementioned periods biomarker tracers also evidence that zooplankton (and its fecal pellets) are important constituents of the export POC flux. As for the terrestrial inputs, they are mostly characterized by a high peak in late spring/early summer, when enhanced riverine discharges occur.

Our findings demonstrate that the export of biogenic elements is closely linked to the structure of the biological system. The latter is largely controlled by hydrological features (physical forcing). The absence of a “typical” spring bloom, in line with historical data since the mid 90’s, reflects the impact of warming and associated limited nutrient supply into surface waters due to weaker mixing during mild winters. Instead, diatoms bloom rather in autumn with a strong phase in November. Increased stratification with a shallow mixing zone and most favorable light and temperature conditions lead to a strong coccolithophorid bloom in early summer (overlooked by satellite Chl assessments).

We further compare our findings with available in-situ and satellite data and with a coupled physical–biogeochemical model in order to progress in our understanding of the dynamics of export biogenic fluxes in the Black Sea and its links with the biological community structure, the biogeochemical functioning of the Black Sea system and environmental changes.