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Microbial plankton responses to multiple environmental drivers in marine ecosystems with different phosphorus limitation degrees

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Abstract:

Multiple drivers are threatening the functioning of the microbial food webs and trophic interactions. Our understanding about how temperature, CO_2, nutrient inputs, and solar ultraviolet radiation (UVR) availability interact to alter ecosystem functioning is scarce because research has focused on single and double interactions. Moreover, the role that the degree of in situ nutrient limitation could play in the outcome of these interactions has been largely neglected, despite it is predominant in marine ecosystems. We address these uncertainties by combining remote-sensing analyses, and a collapsed experimental design with natural microbial communities from Mediterranean Sea and Atlantic Ocean exposed to temperature, nutrients, CO_2, and UVR interactions. At the decade scale, we found that more intense and frequent (and longer lasting) Saharan dust inputs (and marine heatwaves) were only coupled with reduced phytoplankton biomass production. When microbial communities were concurrently exposed to future temperature, CO_2, nutrient, and UVR conditions (i.e. the drivers studied over long-term scales), we found shifts from net autotrophy [primary production:respiration (PP:R) ratio > 1] towards a metabolic equilibrium(PP:R ratio ff 1) or even a net heterotrophy (PP:R ratio<1), as P-limitation degree was higher (i.e. Atlantic Ocean). These changes in the metabolic balance were coupled with a weakened phytoplankton-bacteria interaction (i.e. bacterial carbon demand exceeded phytoplankton carbon supply. Our work reveals that an accentuated in situ P limitation may promote reductions both in carbon uptake and fluxes between trophic levels in microbial plankton communities under global-change conditions. We show that considering long-term series can aid in identifying major local environmental drivers (i.e. temperature and nutrients in our case), easing the design of future global-change studies, but also that the abiotic environment to Which microbial plankton communities are acclimated should be taken into account to avoid biased predictions concerning the effects of multiple interacting global-change drivers on marine ecosystems.

Keywords: carbon dioxide, metabolic balance, nutrients supply, phytoplankton-bacteria relationship, ultraviolet radiation, warming