Global change, together with human activities, has resulted in increasing amounts of organic material (including nutrients) that water bodies receive. This input further attenuates the penetration of solar radiation, leading to the view that opaque lakes are more "protected" from solar ultraviolet radiation (UVR) than clear ones. Vertical mixing, however, complicates this view as cells are exposed to fluctuating radiation regimes, for which the effects have, in general, been neglected. Furthermore, the combined impacts of mixing, together with those of UVR and nutrient inputs are virtually unknown. In this study, we carried out complex in situ experiments in three high mountain lakes of Spain (Lake Enol in the National Park Picos de Europa, Asturias, and lakes Las Yeguas and La Caldera in the National Park Sierra Nevada, Granada), used as model ecosystems to evaluate the joint impact of these climate change variables. The main goal of this study was to address the question of how short-term pulses of nutrient inputs, together with vertical mixing and increased UVR fluxes modify the photosynthetic responses of phytoplankton. The experimentation consisted in all possible combinations of the following treatments: (a) solar radiation: UVR + PAR (280–700 nm) versus PAR (photosynthetically active radiation) alone (400–700 nm); (b) nutrient addition (phosphorus (P) and nitrogen (N)): ambient versus addition (P to reach to a final concentration of 30 µg P L^{-1}, and N to reach N:P molar ratio of 31); and (c) mixing: mixed (one rotation from surface to 3 m depth (speed of 1 m 4 min^{-1}, total of 10 cycles)) versus static. Our findings suggest that under ambient nutrient conditions there is a synergistic effect between vertical mixing and UVR, increasing phytoplankton photosynthetic inhibition and excretion of organic carbon (EOC) from opaque lakes as compared to algae that received constant mean irradiance within the epilimnion. The opposite occurs in clear lakes where antagonistic effects were determined, with mixing partially counteracting the negative effects of UVR. Nutrient input, mimicking atmospheric pulses from Saharan dust, reversed this effect and clear lakes became more inhibited during mixing, while opaque lakes benefited from the fluctuating irradiance regime. These climate change related scenarios of nutrient input and increased mixing, would not only affect photosynthesis and production in lakes, but might also further influence the microbial loop and trophic interactions via enhanced EOC under fluctuating UVR exposure.