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The paradox of increasing long-term carbon sequestration in lake ecosystems despite reoligotrophication : the case of four large French perialpine lakes

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Although lakes only represent a small fraction of the surface of the earth, a growing number of studies have shown that they play a critical role in the global carbon cycle ([i],[ii],[iii]), mediating carbon transfer from land to the atmosphere, and burying organic carbon in their sediments. The magnitude and temporal variability of carbon burial is, however, poorly constrained, and the degree to which lake productivity has influenced lake carbon cycling has not been systematically assessed ([iv]). Here, trends in total organic carbon (TOC) sequestration and primary production are reconstructed from sediment records for the last 300 years in four perialpine deep lakes. We rely on High Performance Liquid Chromatography (HPLC) and geochemical proxies to investigate changes in algal communities. Then, we evaluate the temporal contribution of algal assemblages to the variability of lake primary production, as well as the potential effects on carbon sequestration magnitude. Other contributors to carbon sequestration derived from the IPER RETRO project (2009-2013) are also investigated, such as past oxygen conditions, lake thermal structure or allochthonous supplies of carbon. Our results suggest that despite reoligotrophication of all lakes (e.g., decrease in dissolved phosphorus concentration in water column and relative restoration of diatoms communities ([v])) over the last 3 decades, TOC in lakes sediments is still increasing in the sediment. The study of algal pigments suggests that changes in algal assemblages and oxygen conditions could be responsible of this persistent increase in carbon burial. Future development (e.g., DNA analysis) should provide more detail on algal communities to validate these results.

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