Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.37415

Diel patterns compromise the quantification of net CO_2 emissions from dry endorheic inland waters

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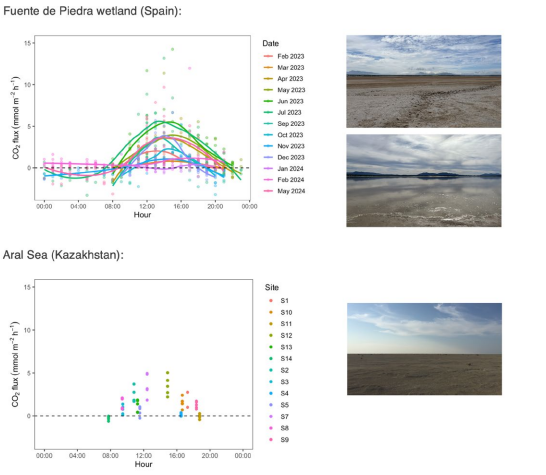

Figure 1

Desiccation of inland waters increases CO_2 emissions by up to an order of magnitude [1]. Endorheic inland waters, considered long-term carbon sinks when flooded, occur in arid and semiarid climates and are especially vulnerable to drying [2, 3]. In these regions, soils exhibit diel CO_2 dynamics, including abiotic nighttime CO_2 uptake [4, 5]. However, although terrestrialisation makes exposed sediments increasingly comparable to soils in biogeochemical functioning [6], equivalent diel CO_2 patterns in dry inland waters remain unexplored. In this study, CO_2 fluxes were quantified in exposed sediments of two endorheic saline ecosystems: the Fuente de Piedra wetland (Spain) and the Aral Sea (Kazakhstan). At the wetland, monthly campaigns were conducted over one year (2023-2024) to characterise diel patterns and their seasonal variability, with CO_2 fluxes measured every two hours from sunrise to sunset. Additionally, four 24-hour campaigns were performed (one per season). To assess the spatial consistency of diel patterns, sunrise-to-sunset fluxes were measured during summer 2022 in the dry Aral Sea, formerly the world's fourth-largest lake. A clear diel pattern was observed in both ecosystems, with peak CO_2 emissions at midday decreasing towards dawn and dusk, when bare sediments exhibited net uptake (Fig. 1). In the wetland, dark uptake occurred year-round except in winter, when no diel pattern was detected. Over 24-hour cycles, CO_2 uptake persisted throughout the night. Consequently, restricting measurements to daytime would have overestimated median daily fluxes by factors of 5.50, 5.01, and 8.50 for summer, autumn, and spring, respectively. Our results reveal diel CO_2 flux patterns in exposed sediments of dry saline endorheic lakes and wetlands and highlight the need to account for 24-hour fluxes to obtain accurate global CO_2 emission estimates from dry inland waters.

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