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Fates of methane from different lake habitats: Connecting whole-lake budgets and CH_4 emissions

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[1] Methane (CH_4) represents a major product of organic matter decomposition in lakes. Once produced in the sediments, CH_4 can be either oxidized or emitted as a greenhouse gas to the atmosphere. Lakes represent an important source of atmospheric CH_4, but the relative magnitudes of the internal pathways that lead to CH_4 emissions are not yet clear. We quantified internal cycling and methane emissions in three lakes during summer stratification. These methane budgets included: sediment release of CH_4 at different depths; water column transport patterns and methane oxidation; methane storage in the water column; and methane emissions to the atmosphere by diffusion and ebullition. The contribution of CH_4 carbon, via oxidation by methanotrophic bacteria, to pelagic food webs was also estimated. Despite the very low concentration of CH_4 in surface waters, shallow, epilimnetic sediments were major contributors of CH_4 to the atmosphere. While 51–80% of the CH_4 produced in deep sediments was oxidized in the water column, most of the CH_4 released from shallow sediment escaped oxidation and reached the atmosphere. Epilimnetic sediments accounted for 100% of CH_4 emitted during summer stratification, and 14–76% considering the release of CH_4 stored in deep water layers during lake circulation after the stratification period; diffusive emission accounted for 26–48% and ebullition the remainder. These results indicate that it is important to address transport rates of CH_4 from the shallow sediment along with the production-consumption processes when trying to understand methane dynamics and the regulation of lake methane emissions.

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