

Seasonal Dynamics of Groundwater Methane Fluxes to an Oxbow Lake in the Yangtze Plain: Hydrological and Biogeochemical Controls

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Methane (CH₄) input to lakes through lacustrine groundwater discharge (LGD-derived CH₄) represents a potentially important, but often overlooked, pathway of lake CH₄ emissions to the atmosphere. Although efforts have been made to quantify LGD-derived CH₄ fluxes and their spatial variability, the underlying mechanisms controlling seasonal LGD-derived CH₄ fluxes and their influence on lake CH₄ emissions remain poorly understood, particularly in humid inland areas. To address this gap, we applied the ²²²Rn mass balance method, as well as hydrological, isotopic and microbial measurements to assess LGD-derived CH₄ fluxes and their influence on the seasonal variability of lake CH₄ emissions in a typical oxbow lake along the middle reaches of the Yangtze River. The lake exhibits large fluctuations in water level between the wet and dry seasons. These were reflected in wide seasonal differences in LGD-derived CH₄ fluxes. During the dry season, despite weaker methanogenesis within the aquifer plus more intense CH₄ oxidation, the much higher LGD rate (51.7 mm/d) produced a higher LGD-derived CH₄ input flux to the lake (16.4 mmol/m²/d). During the wet season, methanogenesis was more active and CH₄ oxidation was weaker, but the lower LGD rate (12.2 mm/d) led to a lower LGD-derived CH₄ input (5.3 mmol/m²/d). Furthermore, in the dry season the higher LGD-derived CH₄ flux and the reduced in-lake CH₄ oxidation resulted in a higher CH₄ emission from the lake. Compared to other lakes, LGD represents a predominant and seasonally distinctive source of CH₄ to the oxbow lake. This study therefore provides a novel perspective on lake CH₄ sourcing and emissions, with potentially significant implications for the role of LGD in carbon cycling and greenhouse gas forcing of subtropical lake ecosystems.

Potential sessions:

10c-Novel insights into biogeochemical cycling in watersheds from source to estuary based on chemical, isotopic and microbiological techniques