



Seasonal and diurnal dynamics of methane fluxes in Typha-dominated wetland treating diffuse agricultural pollution

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Treatment wetlands are recognized as multifunctional ecosystems capable of treating agricultural runoffs. Yet, while their nutrient removal efficiency can be high, it also comes with elevated emissions of greenhouse gases (GHGs), most importantly methane (CH₄). Dense vegetation and availability of nutrients can make these water treatment systems into landscape-scale CH₄ hotspots. Therefore, wetland management practices need to be developed to sustain nutrient removal efficiency while also reducing GHG emissions. Typha-dominated wetlands can modulate microbial processes and plant-mediated fluxes of CH₄. However, understanding these emission patterns requires capturing seasonal trends and diurnal fluctuations. This study investigated CH₄ flux variations and environmental parameters in a Typha-constructed wetland treating agricultural runoff from late spring (May 2024) to the end of the growing season (October 2024). The closed chambers (both opaque and transparent) were used with a LI-7810 trace gas analyzer (LICOR Biosciences). Biweekly measurements of CH₄ and CO₂ fluxes were made at five vegetated sampling spots and five non-vegetated sampling spots. During each sampling occasion, other parameters such as water temperature, pH, dissolved oxygen, oxidation-reduction potential, turbidity, conductivity, leaf area index (LAI), and water depth were measured using portable devices. To examine diurnal variability, three intensive 24-hour sampling campaigns were conducted on June 15, July 22, and August 18. During each of these campaigns, GHG fluxes, and the environmental parameters were measured hourly. The results showed that CH₄ fluxes varied considerably across the five vegetated sampling points over the study period, ranging from 105 μg CH₄-C m⁻² h⁻¹ to over 30,000 μg CH₄-C m⁻² h⁻¹ while the non-vegetated sampling points peaked above 50,000 μg CH₄-C m⁻² h⁻¹. However, a distinct diurnal pattern for CO₂ and CH₄ was observed. CO₂ uptake peaked around mid-day, reaching above -700 CO₂-C m⁻² h⁻¹ driven primarily by photosynthetic activity influenced by photosynthetically active radiation (PAR), while CH₄ fluxes varied with peak fluxes reaching above 10,000 μg CH₄-C m⁻² h⁻¹ observed mostly in the evening (e.g., 4–5 pm and 6–7 pm), clearly driven by elevated temperature. Our studies show how plant growth, microbial activity, and environmental factors interact to regulate greenhouse gas fluxes in treatment wetlands. Understanding seasonal and daily variations is important for monitoring greenhouse gas fluxes and improving wetland management practices.