國 立 臺 灣 海 洋 大 學

海洋環境與生態研究所 專題討論

題目： Wetland methane emissions dominated by plant-mediated fluxes: Contrasting emissions pathways and seasons within a shallow freshwater subtropical wetland

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出處: Limnology and Oceanography (2019) Vol. 64, p. 1895 - 1912

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報告日期: 26/04/2023

Abstract

Wetlands represent the largest natural source of methane; however, very few studies have simultaneously quantified the three main atmospheric flux pathways (i.e., diffusive, ebullition, and plant-mediated). Unlike better-studied northern hemisphere systems, many Australian subtropical wetlands undergo extreme wet/dry oscillations, which may strongly impact methane dynamics. Diurnal methane emissions of multiple pathways were assessed during three distinct seasonal events within an Australian freshwater wetland. Six-fold higher methane emissions occurred during summer compared to autumn floods (which followed an extensive dry-period) and winter/cool conditions. Over three seasons, diffusion represented the highest average areal fluxes (25.9 ± 73.2 mmol m^{-2} d^{-1}) but were within range of fluxes through water lily aerenchyma (20.8 ± 41.5 mmol m^{-2} d^{-1}). Average ebullition rates were 5.5 ± 9.7 mmol m^{-2} d^{-1}. Water column CH_4 displayed high spatiotemporal variability, ranging from 55.0 to 253.5 μmol L^{-1}. Time series δ13C - CH_4 isotope measurements revealed an oxidation fraction of ~ 15% at night-time and ~ 36% during daytime, and night-time diffusive fluxes were consistently ~ three-fold higher than day-time fluxes. By aggregating seasons and weighting for changes in lily coverage, plant-mediated fluxes accounted for ~ 59% of the annual methane emissions, whereas ebullition and diffusion each accounted for ~ 20%. The up-scaled annual area-weighted wetland methane flux (combined pathways) was 27.3 ± 36.7 mmol m^{-2} d^{-1}. We contend that water lilies (*Nymphaea sp.*) are the significant carbon source, mediator, and conduit for methane fluxes in this system, and the extremely large seasonal variability of methane emissions reflect dynamic redox oscillations driven by oscillating wet and dry conditions.