Factors controlling methane flux from riverine wetlands of northen Taiwan

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Natural wetlands are considered the most abundant source of atmospheric methane. Methane emission in wetlands is the result of methane production and consumption mediated by methanogens and methanotrophs, respectively. However, the interplay among methane flux, microbial activities and environmental variables is still unclear. In this study, methane fluxes were measured at five riverside wetlands with different salinities and sulfate concentrations along the Tamsui River in northern Taiwan in summer and winter. Surface sediments and sediment cores were collected for complimentary geochemical characterization. The methane fluxes ranged from 0.01 to 103.6 mmol m^{-2} day^{-1} in summer and from 0.001 to 1.50 mmol m^{-2} day^{-1} in winter. Higher methane fluxes were observed at brackish and freshwater sites, whereas lower methane fluxes were detected at saline sites. The sulfate and methane profiles varied considerably upon salinity well. Sulfate depletion was accompanied with limited variations in methane and low methane abundances at the saline site, whereas the high methane and limited sulfate were observed at the upstream freshwater site. Such geochemical patterns suggest the predominance of either sulfate reduction or methane metabolisms at individual sites. In contrast, various co-variation patterns between sulfate and methane at the midstream sites suggest the interplay among sulfate reduction, sulfide oxidation, methanogenesis and methanotrophy. The measured methane fluxes were also positively correlated with sediment temperatures, but weakly correlated with the fluxes calculated from the methane profiles and from surface methane. No or poor correlations were found between the methane flux and soil pH or organic content. Overall, our results suggest that methane flux is controlled by temperature, salinity (or sulfate) and microbial processes. Despite of the seasonal temperature variations, the interaction and vertical organization of sulfur and methane metabolisms are vital in determining the exact amount of methane exported to the atmosphere.