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In situ Measurements of Dissolved Gas Dynamics and Root Uptake in the Wetland Rhizosphere

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Anaerobic wetland soils are important natural sources of various atmospheric trace gases that are detrimental to the environment, including methane (CH_4), nitrous oxide, elemental mercury (Hg°), and halomethanes. The balance between production and uptake in soils depends, in part, on mass transfer within the soil and between soil and the atmosphere. Observed volatilization rates of trace gases are highly variable and poorly described by models, however, so there is a clear need for new process measurements to clarify the rates of these transport mechanisms.

Here we present results from mesocosm push-pull tests intended to quantify transport processes of dissolved gases in wetland sediments, with a focus on uptake by wetland plant roots and partitioning into trapped gas bubbles. This technique uses a suite of nonreactive volatile tracers to pinpoint transport mechanisms without the confounding influence of biochemical transformations. Mass balance approaches are used to determine transport kinetics, and a new analytical method to interpret dissolved gas push-pull test data is presented and compared to traditional analytical techniques.

Results confirm the key role of vegetation in dramatically enhancing removal rates of dissolved gases from wetland soils. Root uptake is shown to be diffusion-limited and relative root uptake rates are modeled as an empirical function of molecular size. We use the porewater removal rates measured here to estimate potential volatilization fluxes of CH_4, methyl chloride, and Hg° from wetlands vegetated with *Typha latifolia* and *Scirpus acutus*. The implementation of this new push-pull test methodology to field settings will be discussed.