Pulsing of Seawater into Freshwater Wetlands: Effects on Soil Carbon Cycling

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Global sea level is rising at ~3 mm yr^{-1}, making saltwater intrusion a growing threat to freshwater coastal wetlands. Sulfate in seawater is known to decrease CH_4 production, but the affect on CO_2 production is unclear. The relative importance of sulfate (as an electron acceptor) compared salt (as a source of osmotic stress) on C cycling is also unknown. A batch incubation study measured anaerobic respiration and methanogenesis in a freshwater wetland soil exposed to varying concentrations (3.5, 14, and 35 ppt) of seawater and salt (NaCl). In general, seawater stimulated CO_2 production and suppressed CH_4 production in direct proportion to the concentration added. The overall increase in CO_2 production due to seawater was 26-47%, but the effect was short-term, lasting ~2 weeks. Methane production decreased by 94% with 35 ppt seawater and 79% with 14 ppt seawater and the effect persisted throughout the study. Osmotic stress (represented by NaCl treatments) reduced both CO_2 and CH_4 production in the short-term, but production rebounded to rates equivalent to the freshwater control by week 3. Sulfate concentration showed a significant positive correlation with CO_2 production and negative correlation with CH_4 production, while NaCl was positively correlated with available C and conductivity. Results suggest oligohaline wetlands (~3.5 ppt) have the highest C mineralization rate (17% greater than freshwater) because anaerobic respiration is enhanced without a significant reduction in methanogenesis. Seawater wetlands at or above 14 ppt have slightly lower overall C mineralization rates, but C emissions have a low global warming potential.