Modeling Effects of Alternate Wetting and Drying (AWD) on CH4 Fluxes from Managed Wetlands and Rice

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Alternate wetting and drying (AWD) can be used in flooded ecosystems to reduce methane (CH_4) emissions, a powerful greenhouse gas. For example, California has approved an AWD approach for reducing CH_4 emissions from rice fields in the Sacramento valley. Avoided CH_4 emissions can then be sold on the CA Cap and Trade market, thereby incentivizing land management that reduces GHG emissions. Currently, there are limited options for models that can predict the GHG budgets of managed rice and wetlands under AWD scenarios and even fewer than have been parameterized and validated across diverse ecosystems using eddy covariance data. We are using a process-based biogeochemical model called PEPRMT to provide an affordable and accessible option for predicting GHG emissions from managed flooded ecosystems undergoing AWD. In addition, we are incorporating these modeled GHG budgets into a life cycle assessment of managed rice and wetlands.

The PEPRMT model has been parameterized in 2 restored freshwater wetlands and validated in 1 independent wetland site in the Sacramento-San Joaquin River Delta, California. All studied wetlands have managed water tables. The model accounts for CH_4 production and emission responses to changing water table conditions by simulating hydrodynamic flux, CH_4 oxidation, and inhibition of methanogenesis for multiple days following a draining event. The model was successful in simulating CH_4 emission responses to a fluctuating water table in one wetland site and AWD is currently being evaluated to identify best practices for reducing CH_4 emissions in freshwater wetlands.

The model has also been applied to managed rice systems in CA. We used 3 site years of rice data collected in the Delta to parameterize the model and 2 site years to validate the model. We then validated the model using CH_4 chamber data from 2 rice fields in the Sacramento Valley. Model-data agreement was high for all three sites. Annual rice CH_4 budgets in the Delta during validation years were on average 12.5 ± 2.2 g C-CH_4 m^{-2} y^{-1} observed and 15.0 ± 4.5 g C-CH_4 m^{-2} y^{-1} modeled. Agreement was also high for the Sacramento rice fields (r^2=0.7). Overall, preliminary model simulations of AWD in rice suggest that CH_4 budgets could be reduced by 57% by dry seeding and draining fields earlier in the growing season. Life cycle analyses are being used to assess the impacts of AWD on factors including water use, N_2O emissions, and wildlife habitat.