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Modelling CO2 and CH4 fluxes from a Rice Crop grown on Organic Soils in Temperate Climate

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Globally peatlands have been drained for agricultural production, decreasing their carbon sequestration potential, and increasing CO_2 fluxes into the atmosphere. Peatland rewetting can reduce these fluxes, but this can have the undesired effect that food production on this land ceases. The cultivation of flooded rice on peat soils might however protect the peat, reducing CO_2 emissions, whilst maintaining food production. Recently, farmers in Switzerland have started to cultivate paddy rice on flat valley bottoms of the Swiss plateau. However, the cultivation of flooded rice is often associated with high methane (CH_4) fluxes. An outdoor mesocosm experiment was conducted at Zurich Reckenholz (47.42796° N, 8.51769 ° E, 444 m a.s.l.) in the eastern part of the Switzerland's Central Plateau. In 2021, this experiment measured CH_4 and N_2O fluxes (Wüst-Galley et al. 2023)
and CO_2 flux (unpublished data) from rice grown on peat soil (water levels: -6 to -17 cm) and from conventional (deeply drained) grassland. Results showed that the climate impact of the higher CH_4 emissions from the wet rice cultivation was more than compensated by the reduced CO_2 emissions resulting from higher water levels. However, very few modelling studies have investigated the biogeochemical controls exerted by below ground biomass (roots exudates, root depth, root senescence and senescence of the above ground litter) on the resulting CO_2 and CH_4 fluxes from a rice crop grown on peat soils in the temperate climate. The CH_4 transport pathways (plant mediated, diffusion and ebullition) in this same system have not been investigated via modelling. This study utilizes a process-based plot scale model known as Peatland VU to quantify the impacts exerted by the belowground biomass (roots exudates, root depth, root senescence, senescence of the above ground litter) on the resulting CO_2 and CH_4 fluxes. But before quantifying the above-mentioned impacts, the Peatland VU model is calibrated and validated against measured CO_2 and CH_4 fluxes from a rice crop grown on peat soil having controlled water levels (shallow and deep). However, the stabilization of different soil organic matter reservoirs (peat, root exudates, roots and litter, microbial biomass, and humus pool) must be conducted before the

Peatland VU model is calibrated and validated against the measured data. This stabilization is conducted to diminish the influence of initial boundary conditions. In this modelling study, stabilization of the different soil organic matter reservoirs was conducted for 20+ years (1990-2019) using peat hydrophysical properties and past climatic data consisting of daily inputs (precipitation, evaporation, mean air temperatures and solar radiation). The stabilized model was then calibrated and validated against measured CO_2 and CH_4 flux data from 2021 to 2022. The parameters utilized to calibrate and validate CO_2 and CH_4 fluxes will be discussed. The stabilized, calibrated, and validated model will be utilized to test the effect of variable root depths, root senescence, root and shoot factor, exudate factor and senescence of the above ground litter on resulting CO_2 fluxes and dominant CH_4 pathway (plant transport or ebullition or diffusion).