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The influence of different groundwater levels (GWL) on C and GHG dynamics of an agricultural used wetland area

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Agricultural used wetlands with high SOC stocks cover large parts of northeast (NE) Germany. Drainage and modification of groundwater levels by agricultural water management during the last century not only lead to a change in their hydrological processes but also reversed many biogeochemical processes like soil C dynamics and GHG emissions. In addition, climate projections indicate that climate change will substantially alter seasonal precipitation and temperature regimes in NE Germany with an increasing risk of severe summer droughts such as in 2018. Both might have the potential to significantly increase SOC stock losses and GHG emissions. Hence, there is an emergent importance to investigate the interconnectivity between water level, soil C dynamics, and GHG emissions.

To better understand this interconnectivity, we investigated the influence of a different GWL on dynamics of GHG emissions and the net ecosystem C balance (NECB) as a proxy for SOC stock changes. Therefore, GHG emission measurements and estimates of NECB were performed for four weighable lysimeters containing soil monoliths, which were established during 2009 in an agricultural used wetland area (Spreewald region, 51°52'N, 14°02'E). The study site represents an agricultural used (pasture) grassland typical for the Spreewald region. Weighable lysimeters were used to simulate two different GWL regimes: growing season dropdown of GWL due to e.g. summer drought vs. no growing season GWL dropdown. GHG emission measurements (CO_2 (R_{eco} and NEE), CH_4 and N_2O) were conducted campaign wise every 2 to 4 weeks from 2021 onwards, using a manual (N)FT-NSS closed chamber system (Livingston and Hutchinson 1995). In addition, environmental conditions, aboveground biomass development (e.g. plant height, RVI, NDVI) and in situ water parameters (e.g., oxygen, pH, hydrogen carbonate, el. conductivity, temperature, redox potential) were obtained.

Here we present GHG emission measurements and NECB estimates for the first study year of 2021. Higher GWL generally resulted in a lower biomass production. Consequently, clear differences between the two different GWL´s were also obtained in case of derived CO_2 flux components R_{eco} and GPP as well as to a lower extend for overall NEE, with higher GWL showing an only slightly higher overall net CO_2 exchange. Thus, higher NECB values were detected for lower GWL. In contrast, overall GHG emissions (incl. CO_2, CH_4 and N_2O) were lower for lower compared

to higher GWL.