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Greenhouse gas emissions from hydromorphic forest soils: effect of soil type and ground water table

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Even small proportions of hydromorphic soils can significantly influence the net-fluxes of the greenhouse gases CO_2, N_2O and CH_4in terrestrial ecosystems. However, from the great variety of hydromorphic soils, mainly Histosols were investigated for greenhouse gas emissions and there is little information on greenhouse gas fluxes on different mineral soils with hydromorphic properties. The objectives of this study were i) to quantify emissions of CO_2, N_2O and $CH_4$from three different hydromorphic forest soils, ii) to determine the effect of water table position on these fluxes and iii) to analyse the relation between water table position and the total greenhouse gas emission expressed as CO_2 equivalents. Undisturbed soil columns (n = 4, height of 40 cm, diameter of 16 cm) were taken from three typical hydromorphic soil types (humic Gleysoil, histic Gleysoil, sapric Histosol) of the Central Black Forest, Germany. The soil columns were incubated in a greenhouse microcosm system which enabled the setting of different water table positions and the on-line analysis of CO_2, N_2O and CH_4 fluxes. Additionally, the concentrations of these gases and of O_2 were measured in different depths in soil air (unsaturated horizons) and soil water (water saturated horizons). The total experimental period of 140 days consisted of three parts with different setting of the water table (-40 cm, -20 cm, -5 cm). For the comparison of gas fluxes occurring in different periods, temperature corrected flux rates (related to the standard temperature of 17˚C) were calculated using the observed relationships between fluxes and temperature at a given water table. Dynamics of CO_2 emission was similar for all soils. The emission of CO_2 decreased with decreasing depth of the water table and increasing anoxic soil volume. In all soils, emission of N_2O was

highest at the ground water table of -20 cm and an intermediate availability of O_2. Water-saturated, anoxic soil horizons were found to be a N_2O sink. Net-uptake of atmospheric CH_4 was found in the two Gleysoils at a water table of -40 cm. Strong CH_4 emission occurred from all soils at a water table of -5 cm. The results show that the ground water table was much more important for the emission of greenhouse gases from hydromorphic soils than the soil type. Thus, the depth of ground water table seems to be an appropriate factor to stratify ground water influenced soils with respect to greenhouse gas emissions. For all soils, the total emission of CO_2-equivalents was highest at a water table depth of 20 cm.