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One method is not enough to determine denitrification in a Histic Gleysol following different grassland renovation techniques in Northwest Germany

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Grassland renovation by reseeding is a common practices to improve productivity, but knowledge on enhanced nitrate leaching and N_2O emission due to disturbance during associated soil tillage is scarce. Denitrification in hydromorphic soils under agricultural management is potentially extremely high due to the coincidence of high nitrate concentrations, labile organic carbon and oxygen depletion during extended periods of water saturation close to the soil surface (Well et al. 2003; Well et al. 2005). We investigated the impact of grassland renewal or conversion to arable land on greenhouse gas fluxes and N losses in field plot experiments. One of the two sites is a hydromorphic soil (Histic Gleysol) rich in organic C, with groundwater level always within the rooting zone and close to the surface during winter. Assessment of the N budget to estimate enhanced N mineralization following grassland renewal as well as associated N leaching is complicated by potentially complete NO_3^- consumption via denitrification. Robust estimation on denitrification losses at this site is crucial to assess the impact of grassland renewal on its N dynamics and budget. One aim of this study is to determine denitrification in the surface and subsoil in order to close the N budget. We apply five approaches to investigate spatial and temporal dynamics of denitrification and will report first results.

(1) N balance approach: The N budget is obtained by weekly measurement of N_2O fluxes and mineral N in the top soil, mineral N twice a year at 0 to 90 cm depth, N uptake, N fertilization and modeling N leaching based on mineral N and hydrological model data. Unaccounted N is attributed to possible denitrification.

(2) Isotopologue approach: $\delta^{18}O$, average $\delta^{15}N$ and ^{15}N site preference of N_2O as well as $\delta^{15}N$ and $\delta^{18}O$ of NO_3^- are measured at times to estimate N_2O reduction to N_2 in the topsoil during periods of unsaturated conditions using the N_2O isotope fractionation approach (Lewicka-Szczebak et al., 2014).

(3) ^{15}N gas flux method: N_2 and N_2O fluxes from denitrification will be measured periodically by in situ ^{15}N-labelling of soil mesocosms and analysing ^{15}N enrichment of emitted denitrification products (Lewicka-Szczebak et al., 2013). This is to validate results of the isotope fractionation approach.

(4) Excess-N_2 method for groundwater: During winter, dissolved N_2 and Argon are analysed to determine excess-N_2 from denitrification (Blicher-Matthiesen et al., 1999; Weymann et al., 2008). Loss of dissolved N_2 by diffusion will be estimated by modeling (Well et al., 2001).

(5) Emperical functions: Denitrification during phases of water-saturation is modeled based on groundwater level data, organic C, C/N ratio, texture and pH using regression functions for potential denitrification in hydromorphic soils (Well et al., 2003, Well et al, 2005).

All experimental approaches will be presented and first results of N_2O isotopologues, excess-N_2 and modeling denitrification in the saturated zone will be reported.

References

Blicher-Mathiesen, G., McCarty, G. W. Nielsen, L. P. (1998): Denitrification and degassing in groundwater estimated from dissolved dinitrogen and argon. Journal of Hydrology 208(1–2): 16-24.

Lewicka-Szczebak, D., Well, R., Giesemann, A., Rohe, L., Wolf, U. (2013): An enchanced technique for automated determination of ^{15}N signatures of N_2, (N_2+N_2O) and N_2O in gas samples. Rapid Commun Mass Sp 27, 1548-1558.

Lewicka-Szczebak, D., Well, R., Köster, J.R. , Senbayram, M. , Dittert, K., Fuß,R., Flessa, H. (2014): Experimental Determinations of Isotopic Fractionation Factors Associated with N_2O Production and Reduction during

Denitrification, submitted to Geochimica and Cosmochimica Acta.

Well R, Augustin J, Davis J, Griffith SM, Meyer K and Myrold DD (2001): Production and transport of denitrification gases in shallow ground water. Nutrient Cycling in Agroecosystems 60, 65 – 70.

Well R, Augustin J, Meyer K and Myrold DD (2003): Comparison of field and laboratory measurement of denitrification and N_2O production in the saturated zone of hydromorphic soils. Soil Biology and Biochemistry 35, 783 – 799.

Well R, Höper H, Mehranfar O (2005): Denitrification in the saturated zone of hydromorphic soils—laboratory measurement, regulating factors and stochastic modeling. Soil Biology and Biochemistry 10, 1822-1836.

Weymann, D., R. Well, H. Flessa, C. von der Heide, M. Deurer, K. Meyer, Ch. Konrad, and W.Walther (2008): Denitrification and Nitrous Oxide Accumulation in Nitrate-Contaminated Aquifers estimated from dissolved Nitrate, Dinitrogen, Argon and Nitrous Oxide. Biogeosciences 5, 1215–1226.