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Interactive Comment

Interactive comment on “Seasonal variation of gross nitrification rates at three differently treated long-term fertilisations sites” *by* C. F. Stange and H.-U. Neue

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Dear Editor Albrecht Neftel,

First of all we would like to thank all of you for this very stimulating and interesting discussion. You are absolutely right that the BaPS system measures CO2, O2 and the internal pressure with three different sensors and that the gross nitrification is calculated based on these measurements. This could be seen in fact as a disputable point, but up to now a number of studies tested and calibrated the BaPS system successfully (Ingwersen et al. 1999; Breuer et al. 2002; Heidenfelder 2002; Müller et al. 2004 , Ingwersen et al. 2008). Compared to data of forest and grassland soils shown in previous studies the lower content of SOM in the upper soil leaded consequently to lower

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turnover rates and therefore we decided to validate the BaPS system again based on an agricultural soil used in our study. Independent from the BaPS system Kahlil et al. (2004) found a strong linear relationship (r2=0.94; Fig 6) between nitrification rate and O2 consumption rate. O2 consumption by nitrification is the base of the calculation in the BaPS system, and this consumption is not negligible compared to mineralization(e.g. Müller et al. 2004). Therefore, we conclude that the BaPS system is an appropriate method to determine gross nitrification rates, in particular if differences between sites and the change in time are in the focus of interest. Of course we tested the BaPS system before starting measurements without probes and also with dummies (seven plastic cylinders with each 100 ml) and no change in CO2 concentration, O2 concentration or pressure over time could be observed in these experiments. We tested the system also with autoclaved soil samples, but autoclaving (by 115°C and 1 bar overpressure) did not only kill the microorganisms but also changes the chemical and physical properties of a soil. Hence, these soils are not in a steady state equilibrium as they would be when measured under "normal" conditions. Consequently we get no linear change of the measured values in a time interval of 24 h. If you believe this is important we can repeat these measurements by killing the microorganisms with chemical substances. Additionally, in the week with frozen soil (5. calendar week) we found practically no change in the concentrations, which can be seen as a distinct indication for the applicability of this method.

In this study we did not measure other N fluxes in the systems with the exception of N2O. We concentrate our measurement on gross nitrification, also to show differences of the gross nitrification rates compare to common net rate determination. N turnover rates in soils are much higher as they can be deduced from using the net rate measurements. Gross rates can be more than one order of magnitude higher as the respective net rates (Stark and Hart, 1997) and net rates can not be used as an indicator for gross rates (Stark&Hart, 1997). Therefore, gross rate measurements are essential to improve our knowledge of the soil N-cycle, in particular with respect to rapid internal cycles. If we estimate 400 kg soil per m^2 in the upper 0.3m (plow layer: bulk density of 1.35 kg/l)

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the conversion factor from μg N /(kg soil and h) to kg N / (ha and year) is 35. Therefore a rough estimation of annual nitrification rates at the three sites is 750 to 1300 kg N / ha*a. This is only a rough estimation because we don’t measured the variation of the nitrification rate with the soil depth and calculate only for the plow layer by the assumption of homogenously rates in this layer. This is also the reason why we give no annual rates in the manuscript. These high turnover rates are is in good agreement with results of a 15NH4+ fertiliser field experiments reported previously (Russow et al. 2008). Also in this study the nitrification rates were very high as indicated by the fact that 3 days after the 15NH4+ enrichment the nitrate pool showed an 15N enrichment equal to that of ammonium pool. After the fertilisation (80 kg N / ha) at least 20 kg ammonium N / ha*d where oxidised to nitrate. Compare to this rates N lost by denitrification is small, the N2O flux of this soil depended on the amount of fertiliser, but was in general smaller then 1kg N / ha*a (Jungkunst et al., 2006). Total denitrification is difficult to estimate, but taking into the account the measured N2/N2O ratios from (Spott et al., 2006) with values between 2 and 55 it can be assumed that the N2 flux is possibly in the order of 10 kg N / ha*a, but not more the 20 kg N / ha*a. Therefore, denitrification is no essential sink compared to the production rate of nitrate in this soil. Leaching is also negligible as indicated by the climatic conditions and the high water holding capacity of this soil. Unfortunately, we can not manifest our hypothesis due to the lack of an appropriate method (15N fumigation extraction method is highly uncertain because it will be calculated using two differences (fumigated-unfumigated; and 15Norg=15Ntot-(15NO3+15NH4)) which increases the calculation error dramatically), but we think that microbial immobilisation is the most important consuming process for nitrate followed by plant uptake. We will include a comparison of N turnover rates in this soil in the revised version of our manuscript.

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