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Interactive comment on "Underestimation of denitrification rates from field application of the ^{15}N gas flux method and its correction by gas diffusion modelling" *by* Reinhard Well et al.

Anonymous Referee #1

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Review of Biogeosciences [Manuscript #2018-495] Title: Underestimation of denitrification rates from field application of the 15N gas flux method and its correction by gas diffusion modelling.

Dear Associate Editor, The manuscript in consideration sought to elucidate whether the field application of the 15N gas flux method underestimates denitrification rates and evaluate the possible reasons by using soil diffusion modelling. The topic is of particular interest to terrestrial biogeochemists attempting to constrain N cycling processes since denitrification is notoriously difficult to measure under field conditions. The authors significantly advance knowledge in this field of research by providing a

first proof of denitrification rates underestimation due to subsoil diffusion and storage of denitrification products as stipulated previously by research published in this journal. Even though the authors provide strong indications that subsoil diffusion is indeed occurring during field application of the 15N gas flux method I am not convinced of the practical applicability of soil diffusion modelling for correcting this discrepancy. The significant difference between measured and modelled results suggests there is too many unknown factors (e.g. spatial variability of diffusivity) and that further assumptions (beyond the homogenous soil labelling of the 15N gas flux method) need to be introduced to model surface flux and subsoil diffusion and storage. I am wondering if the soil diffusivity assumptions (homogenous soil pore structure and water content, absence of stones, roots etc and constancy of diffusion and production rates) are actually introducing more bias than practical improvements to the traditional chamber method (e.g. depth of labelling, size of chamber, open or closed bottom and closure time). The authors suggest that previously published data could be corrected for underestimation by using their model with further parameterisation. This indeed would be something I would be very interested to see and particularly for more challenging soil types than arable land such as grasslands or forests. The manuscript is well structured and clearly written and it seems to me it is a first step towards the right direction for further improving field denitrification measurements. I therefore recommend that the manuscript is accepted for publication following a few minor corrections and clarifications detailed below: Minor comments: 1. P1 Lines 18: End the sentence after total production and start a new one after it. 2. P3 L9 and throughout: Please correct spelling of the word labelled throughout the manuscript. 3. P3 L25&26: In Sgouridis et al. 2016 the labelled nitrate was applied via injections to the soil volume. Please correct the reference and replace with one that surface application was used. 4. P4 L16: Was steady state within the first 6 hours after the label application also measured or just modelled? In the next sentence the assumption stated is that gas production starts at constant rates after the label application. Is it therefore necessary to first establish steady state before applying the model? 5. P10 L22: Reference is repeated twice. 6. P11 L26: It would have been useful if measurements with or without closed bottom cylinder and varying labelling depths and lengths of cylinders were also taken. This could have shown whether the model predictions are true and if there is a significant difference in surface fluxes to justify the use of the model. Perhaps a combination of lower labelling depth, deeper cylinder and larger chamber would result in insignificant subsoil diffusion losses. 7. P19 L2: I agree that it would be a lot easier to apply the model under laboratory closed system conditions. However, pore space/headspace equilibration is relatively easier to achieve than attempting the soil diffusion modelling. The real challenge for the future application of the model would be to apply it under field conditions in more challenging soil types.

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