

## ***Interactive comment on “The influence of tillage on N<sub>2</sub>O fluxes from an intensively managed grazed grassland in Scotland” by N.J. Cowan et al.***

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General remarks: The authors present N<sub>2</sub>O flux data from a permanent managed grassland in Scotland. Thereby a special focus was given to the effects of tillage on fluxes including pre- and post ploughing effects as well as fertilization effects. A commonly used approach to measure N<sub>2</sub>O fluxes are static chambers, which were applied in this study. Additionally N<sub>2</sub>O flux measurements were carried out using dynamic chambers as well as eddy covariance measurements. The study resembles a modified “paired design” study where one side of the grassland was tilled and the other was not. Both areas were covered by chamber and EC measurements leading to a comprehensive dataset with few gaps. A task which is not easily achieved during observation studies. The authors describe and discuss about potential reasons for enhanced N<sub>2</sub>O emissions following tillage and fertilization and provide a solid approach to fill data gaps

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when having sufficient training data. Overall the manuscript is written in a concise and understandable way and the figures are neatly prepared. I have few major comments and provide minor/technical corrections below.

Major Comments: (1) There are yet not too many N<sub>2</sub>O flux datasets from grassland available and even less from tillage. I am wondering why the authors make such a short story out of this valuable dataset. This study is based on three different techniques and the actual discussion on the capability of these techniques to capture the same results differ. Even though the temporal pattern seems to be captured well, there seems also a stable offset (Figure 5) between EC and chamber measurements. This should be further elaborated. (2) When using an approach as in this study, I wonder how the authors assure that the flux from the specific 30min of EC observations originated for consecutive 30min from the area of observation? Did the authors include specific tests to proof that the approach is suitable? (3) A gapfilling approach for N<sub>2</sub>O data is presented which is suitable to be applied at many other N<sub>2</sub>O EC sites. Therefore I suggest to further elaborate on this. (4) The authors provide cumulative N<sub>2</sub>O fluxes for 175days of gapfilled N<sub>2</sub>O data. However it remains unclear how these values shall be set in context with other studies where growing season budgets or annual budgets are presented. Is there any additional data or knowledge that could lead to annual numbers?

These 4 points would make the paper a novel approach to understand N<sub>2</sub>O emission in ears of tillage.

Specific comments and suggestion for improvement: L58ff: the number provided are focusing on a specific time period but this is not indicated, please clarify. Also write kg instead of Kg L62: replace “,” by “.” L63: aeration instead of aerobicity L124: aboveground L131: I suggest to add manual or automatic since this is unclear L134: is that an experiment or rather a survey? see also Eugster and Merbold et al. 2015, SOIL 1 for clarification L134ff: “>30” - dynamic doesn't mean per se automatic, but it remains unclear how you achieved this, so the needed information should be provided

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here already. L152: did you check whether the wind was blowing from the specific area for the specific half-hour? L155: Specs should be given for rainfall, temperature etc measurements: where, how etc? or refer to another paper (Drewer et al. Plant and Soil for instance L176: ID? L177: "prior to measurement" - how long before? L189: how can you assure that this method is suitable to fill the gap? Details, validation is needed. L197: I disagree – Spacsys and PaSIM don't perform too badly – So I suggest to give a reference for your statement L199ff: Can extend this section so that others can choose a similar approach? L202: same model terms compared to what? L232: Where is this shown, similar on which time interval? stats? L234: detection limit of your system? L236: what is your background flux and how was it determined? L237ff: how comparable are these cumulative values to other studies? is that the main growing season, how will the fluxes be during the remaining season? L249: were sheep in the untilled field? L251: how comparable are these cumulative values to other studies? is that the main growing season, how will the fluxes be during the remaining season? L275: "were estimated" or "estimated by least square method?" L279: what do you try to state with the estimated? L283: Was all plant material incorporated or was the field grazed beforehand? when were the biomass samples taken? L287-L295: This is basically a repetition of already presented results. L311: What is your definition of large in comparison to  $0.5\text{nmol m}^{-2}\text{ s}^{-1}$  L321: What about N deposition and mineralisation the soil? L325: any proof or measurement here? Pictures, CO<sub>2</sub> fluxes or likewise? L340: include Butterbach-Bahl et al. 2013 – review here L352: please explain? references? L363ff: no need to restate results - how about setting your results into perspective?

Figure 1: Was there any bias to the dynamic chamber if these are soo close to the cabin? Figure 2: height/depth of measurements? Figure 3: so everything adds up to 100%, correct? NNE high winds only in 2% of the data? correct? Figure 4: why are the EC fluxes all in one line after the fertilization event, are these 30min data or which averaging interval did you use? triangles and squares in grey are difficult to distinguish. What about adding an axis break including the higher fluxes? how much higher than

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12? Figure 5: I suggest in all figures to change the unit indication to "( )" instead of "/"  
Figure 6: This looks really good but I can not see the GAM line in much detail

I hope the comments are helpful and look forward to seeing this paper being published soon. An on-the-fly commented pdf file is attached and if you have question please do not hesitate to contact me.

with kind regards

Lutz Merbold

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