Review of causes and sources for N_2O emissions and NO_3-leaching from organic arable crop rotations

Responses to editor comments made by Dr. Lutz Merbold, May 2019

Thank you for the language corrections and other valuable comments. The suggested language corrections are used in the MS without further comments.

Other comments:

2. Methodology

Line 20-22. (The line numbers refer to the lines in the commented MS received from Lutz Merbold)
Editor: I suggest not to use C as letter here, since you also use it as Carbon. Similarly, I advise against P for duration of period since this could mean Phosphorous. How about F for flux and t for time?
Response: Agreed, done.

Editor: This is not an emissions – therefore I further suggest to use flux as the correct wording
Response: We define *N_2O emission* as "The cumulative flux reported for one field treatment during the actual measurement period". This is commonly done, but we agree that "negative emissions" is a contradictory term. We suggest the following wording, to prevent that the reader from mixing up with daily fluxes. "*F* is the cumulated N_2O flux (emission) in the measurement period (-278 to 8566 g N_2O-N ha^{-1});"

Editor: How about F_{max} instead of N which you also use for nitrogen?
Response: Agreed, done.

Line 23-25.
Editor: This is not clear and sounds rather arbitrary. Just to
Response: The word not had fallen out of the MS. Thank you for observing this. The correct sentence is: "One negative value for average daily N_2O flux (-1.3) in a barley/pea crop was removed from the analyses, since it would not have had a large impact on the results."

Line 26-27.
Editor: How did you come to this decision? why not the 10 or 3 highest flux rates?
Response: The reasoning behind is to provide a picture of the impact of the intensive flux period which often last longer than three days, but rarely as long as 10. However, the choice of five days is a bit arbitrary. This is now briefly explained. "The choice of five days was to represent what typically constitutes a peak emission event."

Line 32.
Editor: Give full reference to Minitab 18 please
Response: Agreed, done. The reference is commonly written like this : "Minitab 18.1, © 2017 Minitab, Inc."

Line 36-37
Editor: Why the highest?
Response: We chose the highest flux rate because we wanted to get extreme values to identify the impact of various factors on hot moments for N_2O flux. This is now argued in the manuscript. "The highest flux rates were chosen for analysis, since we wanted the extreme values to explore which factors are mostly influential for hot moments of N_2O emissions

Line 40
Editor: I suggest to use the formula editor
Response: Agreed, done.

Line 41-43
Editor: What was included in the review? Any additional information – number of studies, which climatic zones etc.?
Response: We changed the placement of this text so it clearer that this is a part of the literature we used for the rest of the text. New placement starts with line 15, new text "We used the available literature to explore the impact of total N added and, N and C added through organic inputs from living plants, plant residues and organic fertilizers on N_2O emission as we did not have enough data on added N to be able to include this in the regression analyses."

3.1 Supply and quality of soil organic matter

Line 15
Editor: By how much? Do you have a percentage?
Response: Exact numbers are difficult to give as there is a large site variation, and values are not always given that make it possible to calculate the percentage. Gomiero et al., 2011 cited other papers, so this reference is replaced with one of the cited papers (Pimentel et al., 2005). The text has been revised as: "Through the application of organic amendments and various crop residues from arable and forage crops, C and N is applied to soil, and the soil organic matter (SOM) content is often higher in organic than in non-organic arable crop rotations (Marinari et al., 2007: about 40% more total organic C short time after application of organic compared with mineral fertilizer; Marriott and Wander, 2006: Concentrations of SOC was about 14% higher in organic than non-organic systems; Gattinger et al., 2012: 3.5 Mg C more in SOC stocks in organic compared with non-organic production in a global meta-analysis; Aguilera et al., 2013: SOC concentration 19% higher in a meta-analysis from Mediterranean; Hu et al., 2018: 0.4 Mg C $ha^{-1}yr^{-1}$ more SOC accumulated with organic than non-organic treatment at Foulum, but 0.4 Mg less C than non-organic at Flakkebjerg in long-term field trials; Pimentel et al., 2005: 15% higher SOC concentrations in legume-based organic versus non-organic crop rotation in a long-term field trial)."

4.1 Mechanisms for N_2O emissions

Line 16
Editor: Microsites of what? Please specify
Response: Microsites refer to sites in the soil where the oxygen concentration in soil is depleted my microbial activity. A microsite can be a fragment of soil aggregate or another limited small plot in soil. To avoid confusion "and/or microsite" is removed.

6. Key drivers of N_2O emissions and NO_3 leaching and suggested mitigation strategies

Page 21, line 15
Editor: This sounds "straight-forward", but how to do so?
Response: This indeed depends on improved technologies and management. However, there are a number of options available that may be used, and a few references are now given.
The new text is: "A way to reduce N_2O emissions and NO_3 leaching per unit produced could be to increase yields in organic production as more land is commonly needed per unit product in organic than non-organic production (De Ponti et al., 2012, Meier et al., 2015). However, as discussed by

Röös et al. (2018) this is not straight forward as many of the available measures have negative side effects. More targeted and thus efficient use of N applied through crop residues and organic fertilizers seems to have co-benefits in terms for higher productivity as well as reduced N_2O emissions and NO_3 leaching. This may be achieved by recycling of these residues through biogas and targeted application to crops according to their N demand (Brozyna et al., 2013; Knudsen et al., 2014).”