Interactive comment on "Isotopic fractionation of N$_2$O to quantify N$_2$O reduction to N$_2$ – validation with Helium incubation and ^{15}N gas flux methods" *by* Dominika Lewicka-Szczebak et al.

Anonymous Referee #3

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General Comments

The manuscript entitled, "Isotope fractionation of N2O to quantify N2O reduction to N2- validation with Helium incubation and 15N gas flux methods," details a series of experiments to validate a new method for determining the amount of N2O reduction through mapping the isotopic values of N2O. This method was compared to two types of traditional incubation methods. I think that this work is substantial and would add to the field of N2O isotopes.

While I agree with the science, I found the presentation of the material in writing and figures to be poor, and the information barely accessible to the reader. I had a very difficult time understanding parts of the manuscript, and believe it should not be published

as it is. The sentences were often long and awkwardly written. Additionally, many of the terms were not well defined and described early in the manuscript. Then when the results were presented it was difficult to understand what each variable meant, and why they were important. The figures were also cluttered with too much information. I would have liked to seen there be more things distilled down for the reader, rather than showing all the data and every experiment. I wonder if all the experiments or data should be presented in one paper or if some of this information would be best split into multiple manuscripts.

With all that said, I do think there is intellectual merit in the experiments that were preformed and the results they found. I think the "mapping approach" presented would be a more efficient and easy way to determine N2O reduction in the environment rather than using incubation methods that are expensive, time consuming and riddled with caveats. In the manuscript they also defined the clear weak points of this new method, namely knowing the δ0, which will steer future research to improve the method in this area. With substantial revision this paper will be a great addition to the field.

Specific Comments

P1 L1- I would suggest editing the title to make it catchier and less awkward.

P1 L10- Rephrase, "the main unknown magnitude"

P1 L11- Define in the abstract what the residual fraction is.

P2 Introduction- Add more description on the importance of being able to determine N2O reduction. Also, give a better background on all the important terms to be later used in the manuscript and why they are important. A figure or table might be helpful for showing previous work and how the terms fit into the overall picture.

P2 L4-6, P3 L1-3, P3 L26-28- Long and awkward sentences, consider rewriting.

P4 L19- The heading title has "experiment 1 and Exp 1" I would only write it once in the title.

P5 L2- Missing "a" in "application of a N2-free atmosphere"

P5 L15- Fix section heading, as above.

P5 L21- Why is the nitrate treatment different in Exp2 than Exp1?

P6 L8- Define NA.

Supplemental Figures S1 and S2- I suggest removing some of the variables from the figures and putting a simplified figure in the main text. I was also confused with the labeling and order of the figure S2, such that it went from 2.1 a) to 2.2 a) and then back to 2.1 b), could you combine panels onto 1 page and make them a b c and d?

P14 L24- In the "mapping approach" how much will the answer change if you use different end member values? The boxes for possible values are large and suspect it could be large.

P15 L2-7: What is the value are you referring to in this paragraph?

P16 L1: I was surprised that the reduction isotope ratios were the same for oxic and anoxic incubations. Why is that?

P19 L3: What is N immobilization?

P19 L17: What is hybrid N2O? Could you define it earlier in the manuscript?

P20 L4: What correlations?

P21-22: What are the differences between Val 1 and Val 2? Can you state them more clearly before presenting the results?

P22 L25: Could the data in Table 3 be put into a simplified graph in the main text? That might be helpful for the reader.

P25 L10-15: I'd suggest putting the historical data in a table with the current findings.

P27 L22: The title "Calibration and Validation" is vague, calibration and validation of

what?

Table 1: I suggest putting the full names of the variables in the table header row.

Figure 2 and 3: Why is the x-axis on the right hand side?

Figure 4, 6 and 8: Symbols are similar and hard to distinguish in the figure.

Figure 5: There is no legend.