Biogeosciences Discussions

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Reply on RC2

Alison Bressler and Jennifer Blesh

Author comment on "Episodic N_2O emissions following tillage of a legume–grass cover crop mixture" by Alison Bressler and Jennifer Blesh, Biogeosciences Discuss., https://doi.org/10.5194/bg-2022-39-AC2, 2022

Section 1: "The manuscript is well written and assessing interesting question regarding the effect of cover crop (and mixtures) incorporation on soil nitrous oxide emissions. At KBS site measurement length seems to be appropriate for the question asked, at the CF site, however, the post-incorporation peak emissions have not finished before the last measurement (e.g. Fig 2). Thus, cumulative emissions calculated for the CF cycle likely underestimated. This problem can be addressed, at least partially by additional analysis of the existing data."

Author's Response: Thank you for your positive feedback on the manuscript, and for this helpful comment regarding the data at *CF*. We agree this is the case for the clover treatment at *CF*. We now better acknowledge in the discussion that the estimate for cumulative emissions at *CF* is likely an underestimate. We will add an analysis in section 4.1 to provide a possible range of cumulative emissions for this treatment had we measured for a longer period: "We likely underestimated cumulative N_2O emissions during the first peak following tillage at *CF* because emissions had not yet returned to baseline, especially for the clover treatment. By extending our empirical measurements using regression models, we estimated the trajectory of N_2O emissions to approximately 19 – 26 days after tillage depending on the cover crop treatment and replicate. We estimate that cumulative N_2O emissions could have reached 822.8 ± 253.2 g N_2O N ha^{-1} in clover, 461.6 ± 59.2 g N_2O N ha^{-1} in mixture, 340.4 ± 63.4 g N_2O N ha^{-1} in rye, and 355.0 ± 77.4 g N_2O N ha^{-1} in fallow. These higher estimates further increase differences in cumulative N_2O emissions between sites."

Section 2: "I think that authors should include analysis of post-incorporation emissions from the KBS LTER site since, I guess CF site doesn't have long-term soil N_2O emissions data. Within existing data authors can find times of cover-crop incorporation across the KBS dataset. By finding measurements of post-incorporation emissions and compare them to total annual/seasonal emissions, authors can prove that post-incorporation emissions indeed contribute significant amount of N_2O emissions. This will improve the manuscript and make it more suitable for publication. I agree with the first reviewer comments and don't want to repeat them, however, I think that incorporation of additional analysis will make this manuscript suitable for publication, despite limited novelty pointed by the reviewer 1."

Author's Response: Thank you for this great suggestion! Based on historical N_2O data at

the KBS site, we analyzed N_2O emissions when they were measured within four weeks following incorporation of the red clover cover crop in the organically managed treatment at KBS. We will report this to add additional context to our short- measurements in **section 4.3** of the discussion: "Additionally, we used long-term measurements of N_2O emissions from the biologically-based cropping system at KBS as further context for interpreting our single-season results. Between 2014 and 2020, following the red clover cover crop, we found three instances of N_2O being measured roughly two weeks apart within a month of tillage. These two-week periods of N_2O emissions after tilling red clover represented 19.9 ± 2.04 % of the annual emissions from this cropping system (Robertson 2020). These N_2O measurements from past years at the KBS site were not collected until at least 8 days after tillage, and likely missed the initial flux immediately following soil disturbance, which may explain why we found a slightly higher proportion of annual emissions (26.3%) following clover tillage at *KBS*. These historical data suggest that we indeed captured the peak N_2O flux following soil disturbance by tillage in our one-year experiment."

Robertson, G.: Trace Gas Fluxes on the Main Cropping System Experiment at the Kellogg Biological Station, Hickory Corners, MI (1991 to 2019) ver 46, Environmental Data Initiative, https://doi.org/10.6073/pasta/b1feb30692eb31b7f8a27615d18e0fa8 (Accessed 2022-02-11), 2020.

Section 3: "Two technical comments: 1. please use appropriate decimal numbers in current version you use non, one, and two decimal numbers sometimes in the same paragraph (L237, section 3.2). 2. Figure 2, please do not use smoothing line or connection line - you have not measured continuously."

Author's Response: Thank you for picking up on the inconsistency. We have checked for decimal places to be consistent and made edits. We appreciate this comment about the smoothing line but would also argue there are differing opinions on the acceptability of this approach in the literature on N_2O emissions. In this case, the smoothing lines greatly improve the visualization of the patterns between treatments and across sites and we prefer to keep them in. We explain in the methods exactly how we calculated/estimated this curve (see Eq. 2 on line 180). We will also mention the limitation of this approach after the equation in the methods: "In the absence of continuous sampling, this approach allowed us to approximate a total flux over the sampling window and better visualize treatment patterns within and across sites." We will also add a note to the Figure 2 caption: "The lines connecting the sampling points are intended to aid in visualizing treatment patterns for cumulative N_2O and do not indicate continuous data collection (Eq. 2)."