Biogeosciences Discussions

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Reply on RC2

Rodrigo Vargas and Van Huong Le

Author comment on "The paradox of assessing greenhouse gases from soils for nature-based solutions" by Rodrigo Vargas and Van Huong Le, Biogeosciences Discuss., https://doi.org/10.5194/bg-2022-153-AC2, 2022

Response to reviewer

Comment: Title of the manuscript: "The paradox of assessing greenhouse gases from soils for nature based solutions" addresses an important topic and will help to improve our understanding of the greenhouse gas fluxes from the soils. Manual chamber techniques are currently widely used for measuring the three GHG fluxes from soils, since they allow parallel deployment of multiple treatments and lands. However, it requires a lot of care and post-field lab analyses thus limiting temporal representations due to its labour-intensive nature. Since soil N2O and CH4 exhibit sporadic peaks due to their time resolution, a significant problem may arise here; however, CO2 may not be a big concern since it tends to be highly autocorrelated. The availability of automatic chamber sampling thus improves this time resolution concern but they are quite pricey.

Response: We appreciate the detailed summary of this study by the reviewer.

Comment: In this manuscript, as compared to a fixed sampling, the author presents a novel approach for monitoring soil GHG fluxes using temporal univariate Latin Hypercube sampling. The authors used an annual dataset (Sept 2014-Sept 2015) for the three GHGs monitored at 45-minute intervals in a temperate forest. By using temporal univariate Latin Hypercube sampling, each subset of GHGs in the annual dataset is selected based on its statistical properties and temporal patterns. This method reduces bias introduced by fixed sampling, especially for small samples size. In the end, the authors conclude that while these results are crucial for assessing GHG fluxes from soils and reducing uncertainties concerning soils' role in nature-based solutions in the future, the approach needs to be tested across different ecosystems, which may result in different site-specific recommendations.

Response: We appreciate the detailed summary of this study by the reviewer.

Comment: I thus believe that the topic is very interesting and of great relevance to Biogeosciences. The manuscript is well written and has a good structure in terms of design and evaluation results. There is a great deal of work done by the authors in discussing the

results, and they have well referenced them. Apart from a few minor changes to the manuscript, I believe that the work is very relevant and very important.

Response: We appreciate the detailed summary of this study by the reviewer.

Comment: For example, the authors should briefly explain the annual weather pattern for the study area. It would be interesting to see how this vary annually to relate with the trend pattern of the gases.

Response: We will add references to other studies that have used micrometeorological measurements in an adjacent area to show the temporal variability (Hill et al 2021; Vazquez-Lule and Vargas 2021). This can be edited in the methods section.

That said, we do not have long-term information of soil GHGs with weather patterns. In previous studies we have identified that soil temperature is a strong driver for CO2 but not for CH4 nor N2O in soils (Barba et al 2019). We will edit the discussion section to revise our assumptions and the applicability of this approach.

Hill, A. C., A. Vázquez-Lule, and R. Vargas. 2021. Linking vegetation spectral reflectance with ecosystem carbon phenology in a temperate salt marsh. Agricultural and Forest Meteorology 307:108481.

Vázquez-Lule, A., and R. Vargas. 2021. Biophysical drivers of net ecosystem and methane exchange across phenological phases in a tidal salt marsh. Agricultural and Forest Meteorology 300:108309.

Barba, J., R. Poyatos, and R. Vargas. 2019. Automated measurements of greenhouse gases fluxes from tree stems and soils: magnitudes, patterns and drivers. Scientific reports 9:4005.

Comment: Since means from univariate Latin Hypercube sampling and fixed sampling did not differ statistically, is it possible to estimate annual GHG fluxes by adjusting weekly fixed sampling?

Response: The means from FTS and tuLHS were not statistically different but that does not mean that cumulative sums nor uncertainty are similar (see Figure 5). Our results show that the cumulative sums and uncertainty derived from FTS are biased for all GHGs (Figure 5). The tuLHS approach consistently provided closer estimates for cumulative sums and uncertainty ranges than FTS for all GHG fluxes. We will revise the wording in the manuscript to emphasize the results of Figure 5.

Specifically

LN 106: What is the reason for using 45 minutes rather than hourly intervals?

Response: This is a mistake in the methods section, and we appreciate the reviewer for identifying this typo. The original time step is 1 hour as described in Petrakis et al 2018. We will correct this mistake in the revised version.

LN 117: Could a flux calculation that only considers the highest R2 eliminate low fluxes?

Response: Not necessarily because low fluxes can also have high R2 values. This is a common approach to decide if a flux should be kept for further calculations. Based on past work, we have seen that using a linear fit for CH4 and N2O fluxes reduces bias in eliminating low fluxes (e.g., Barba et al 2019).

Barba, J., R. Poyatos, and R. Vargas. 2019. Automated measurements of greenhouse gases fluxes from tree stems and soils: magnitudes, patterns and drivers. Scientific reports 9:4005.

LN 232: Does this site's N2O lack a temporal dependency for any biological reason?

Response: The site is an upland forest where no additional fertilization is applied. In all our measurements we have found that N2O emissions are low and do not have clear seasonal patterns nor diel variability (Petrakis et al 2018, Barba et al 2019). There are not many automated measurements of N2O in upland forests to compare our estimates, but we are aware that in agricultural systems there may be a stronger temporal pattern of N2O.

Petrakis, S., J. Barba, B. Bond-Lamberty, and R. Vargas. 2018. Using greenhouse gas fluxes to define soil functional types. Plant and soil 423:285–294.

Barba, J., R. Poyatos, and R. Vargas. 2019. Automated measurements of greenhouse gases fluxes from tree stems and soils: magnitudes, patterns and drivers. Scientific reports 9:4005.

LN 243: Include the CO2 unit after 5.9, also LN 257 include unit of CH4 after -0.93,

Response: We will revise units along the manuscript.

LN 545: Figure A1 does not indicate the graph for soil CO2 (FA CO2), but repeats soil N2O (FA N2O) fluxes.

Response: We are confused about this comment. That said, we will edit this figure to improve clarity as suggested by Reviewer #1.

LN 569: The horizontal blue line is not clear. Could you consider using brighter green instead?

Response: We will edit this, and other figures as suggested by Reviewer #1.