

Biogeosciences Discuss., referee comment RC1
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Comment on bg-2021-198

Anonymous Referee #1

Referee comment on "Assessing the spatial and temporal variability of greenhouse gas emissions from different configurations of on-site wastewater treatment system using discrete and continuous gas flux measurement" by Jan Knappe et al., Biogeosciences Discuss., <https://doi.org/10.5194/bg-2021-198-RC1>, 2021

The manuscript describes greenhouse gas flux measurements from a constructed domestic waste water treatment system (using percolation through soil along trenches). The study reasonably includes all stages of effluent, from septic tanks to trenches (where effluent is introduced below-ground through pipes), and vents to the atmosphere. Collecting this kind of data is challenging, given the seasonal and diurnal fluctuations, and events such as ebullition and flushing through vents. The combination of spot measurements and use of continuous chambers is hence appropriate.

My main issue with the analysis is the framing of fluxes in comparison to control soils. This may seem reasonable, as any changes from undisturbed ("natural") conditions would be attributed to the use of effluent treatment. However, the results indicate significantly reduced fluxes of CO₂, which the authors interpret as a net sink of CO₂ through effluent treatment. It is grossly simplistic, as the fate of C introduced from domestic effluent is not explained or even considered. To become a sink of CO₂, the soils have to assimilate C somehow, but no such mechanism is proposed. Measurements use dark chambers, so potential fertilisation effects on vegetation resulting in increased photosynthesis can not account for this finding. It is more likely that the soil disturbance, including replacement of soil by gravel, has reduced CO₂ flux artificially in the treatment beds. A true control treatment would have been required, with trench construction and hence disturbance identical to that of the effluent treatment beds.

To be publishable, the authors have to re-evaluate the flux calculation (which is never presented or explained in the methods). The assumed "net CO₂ sink" has a major influence on the net GHG balance, which is not robust, and can not be presented as such.

There is relatively little discussion of results. References are included to compare individual aspects to literature, but I missed a comprehensive evaluation. Maybe a separation of 'Results' and 'Discussion' would work better.

On balance, I struggle to justify the publication in Biogeosciences. Microbial processing and GHG implications of domestic effluent is included, which is good, but I missed a reliable treatment of interaction with soil biota, and consideration of sources and sinks beyond a simplistic flux comparison (which would make this paper relevant to BGS). It's a shame, as the data set is impressive, and surely useful for assessing GHG impacts such domestic schemes. Unfortunately, the designed is flawed by lack of a true control, making it difficult to provide robust GHG budgets.

Detailed comments

76: Can you give at least some detail of what a 'rotating biological contactor' is?

103: I'm unsure what "each of the two ST chambers" means. There seems to be no descriptions of "chambers" of STs, and it becomes confusing when you describe flux chamber measurements.

167-184: Section 3.2 reports results that are not part of this study, and don't relate to methods presented earlier. Please either present methods of measurement to obtain these values in the methods, or integrate the information provided here into the description of sites and STUs.

232/233: This should be Figure 2B (?)

269/270: Reported fluxes of 0.00, and a range of [0.00; 0.00] are not meaningful. If fluxes were measured, they should be reported with three significant figures, whatever the magnitude. The same applies in line 274.

284: You state "clearly seem to increase", but later state that results are not statistically significant, which is contradictory.

311-314: This largely repeats information already given in the Methods.

325: If the net flux of CH₄ is negative, the STU as a whole (comprising effluent for STs, soil and vegetation) is a net sink of CH₄. The 'natural' CH₄ sink (measured on control soils) has been diminished due to gross CH₄ emissions increasing, but the net term remains negative.

340: The 'median net uptake' is not well explained, and I think even misleading. The data show positive CO₂ fluxes for all treatments, and as I assume the chamber was obscure, there is no realistic prospect of CO₂ uptake (but possibly for methane). Here. You seem to refer to the difference between effluent treatments in the STU to control soils, where a lower flux in treatments is deemed a 'net uptake'. If at all, this would be a gross uptake, as the net effect of all processes is evidently still a source of CO₂. I suggest moving away from the terminology of 'net uptake' when discussing these fluxes, and provide interpretation of possible mechanisms and processes in the discussion.

Figure 4: Extremely high CO₂ fluxes are not really plausible (especially in control plots). Have flux regressions been quality-checked?

Figure 4: Colours mean different things between panels, which is confusing. For A, panels already separate location, so no need to use different colours. I assume that the locations are the same in Panel B (i.e. PE on left, Se in middle, Control on right)?

353: "in the west of Ireland", or "in western Ireland".

354-356: Was there a notable flux response to the drought period, and did it differ between STU and control plots?

362- 365: This sentence on relative contributions is hard to interpret. Can you explain your distinction of absolute vs. relative fluxes better?

424-427: Avoid repeating methods here.

459: The same problem with presenting significant figures. Please don't present fixed number of decimal places, but instead always the same number of significant figures for all fluxes.

479: "higher lower"?

509/510: This is not correct. Units should be kg CO₂-eq cap⁻¹ yr⁻¹. Likewise in lines 622 and 623. (Please check throughout text!)

Figure S2: Please provide more information in the figure caption to allow readers to follow what's shown without reading the text in detail. What are the two colours, and what are "chamber 1" and "chamber 2"?