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Biogeosciences Discussions

Interactive comment on "Isotopic fractionation corrections for the radiocarbon composition of CO_2 in the soil gas environment must include diffusion and mixing" *by* Jocelyn E. Egan et al.

Jocelyn E. Egan et al.

jocelyn.egan@dal.ca

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Thanks to the referees and the editor for helpful comments that have led to a much-improved manuscript. Referee comments are listed and our responses follow each - line numbers refer to those in the revised version.

Sincerely, Jocelyn Egan (for all authors)

Referee #1

The reviewed manuscript proposed new corrections for 14C measurements in soil air, to account for diffusion and mixing. Experimental study, and modeling are used to illustrate the point, and recommendation for best practice are given. The logic of the authors is clear, and usually the manuscript is well written. Thanks for the supportive comments. The authors writes that the problem with the traditional method of 13C based correction, is that it works only for biological process like photosynthesis and do not apply for example to fractionation in diffusion. This is not correct. The correction based on 13C should work for any mass-dependent fractionation (i.e most fractionation processes). However, they are correct the traditional correction will not work for mixing. Because this is not a fractionating processes and no mass-dependent can be assumed. This error should be corrected in the text, abstract, and in the title (i.e. correction for mixing is not correction for fractionation).

Response: We agree, and this is merely an issue of terminology. Although mixing might not be considered a traditional fractionating process, there are important isotopic effects associated with mixing. An isotopic fractionation is defined as a difference in the isotopic composition between a reactant and a product. For the application here with radiocarbon, the radiocarbon composition of biological respiration is the "reactant" and the soil gas is the "product". We must take into account all isotopic effects that influence the product in order to understand the true isotopic composition of the reactant. Therefore both diffusion and mixing need to be included and accounted for and that is the central message of our paper. We have changed wording in the text to address this:

Title: removed the word fractionation.

Page 3 lines 6-7.

Another point that can be mentioned in the text: In soils that contain carbonates, isotopic exchange of CO2 with the carbonates can introduce additional error which is not

mass-dependent.

Response: Agreed, but carbonates are not the focus of the paper.

It is stated that: “Graham’s law of effusion (rate of diffusion âĹij 1/sqrt(mass)) provides us with an expected difference in diffusion rate of isotopologues.” In fact, as it is written few lines before, this is a binary diffusion of CO2 in air and hence binary diffusion equation (a one that invokes reduce-mass of CO2 and air) should be used.

Response: Agreed. We have modified the text to remove the mention of Graham’s law (see line 19 on page 5).

Minor comment: Please give a better description of the soil than just “clay”.

Response: More detail has been added (lines 21-23 on page 11). âĂČ

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2018-451/bg-2018-451-AC1-supplement.pdf

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