

Interactive comment on “The role of soil pH on soil carbonic anhydrase activity” by Joana Sauze et al.

Anonymous Referee #2

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The paper “The role of soil pH on soil carbonic anhydrase activity” by Sauze, Jones, Wingate, Wohl, and Ogée explores the role of pH on soil carbonic anhydrase (CA) activity by combining a novel experimental setup with a rigorous model framework. The authors are thereby able to compare measured rates of oxygen isotope exchange and CO₂ hydration, and their response to pH, versus theoretical expectations. The results of this study confirm in many cases the mechanistic understanding of the role of pH on soil CA activity. In the process, the authors reveal the potential role of soil complexity on the bulk behavior of soils including heterogeneous distributions of water content, temperature, porosity, enzymes concentrations, and respiration rates. Using their model framework, Sauze et al. are able to evaluate some of these sources of variability and inform critical and current discussions in soil science, such as whether distinct isotopic pools of water exist in soils. This manuscript thus makes important contributions to the study of the role of soil CA activity and its pH dependence and to a

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broader body of research in soil science.

P2L3: This sentence describing the role of the terrestrial biosphere in compensating for anthropogenic CO₂ emissions is difficult to understand, and should be clarified.

P2L14: Is this the correct reference for direct CO₂ measurements?

P2L33: Variations in soil properties affecting diffusion rates would also be important, and could be mentioned.

P3L14: More fitting would be to suggest that a direct link between at the activity of at least some CA in soils and soil pH should exist because the case was just made that the intracellular CA may not experience environmental pH fluctuations.

P3L22: This is an important point regarding the mode that CA enhancement has been reported in the past. The point would be more effective by clarifying the sentence more. For example, the ‘enhancement factor’ is not defined before its first mention in line 21 making it difficult for the reader to know how it is different from the uncatalyzed rate mentioned.

P7L32: What is the meaning of spatially-averaged here? Does this just mean that the kinetic parameters are average values for the volume or mass of soil, or should spatially-averaged refer to something more specific? If so, would be good to clarify.

P10L34: 16S and 18S rRNA or rDNA gene copies. No detectable difference in these gene copies does show no significant change in community structure in response to CA addition, but it does not necessarily mean that native CO₂ hydration rates were unchanged because microbial communities may have modulated their CA gene expression and enzyme production rates, and thus native CO₂ hydration rates, in response to the availability and activity of exogenous alpha CA.

P11L36: Results for these model results should be given, even if just summarized briefly as a % change from steady-state conditions. Also for P12L16. Could a figure for just one site be added to illustrate the difference between steady- and non steady-

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state?

P12L1: Reader should be pointed to Table 1 to look for phosphate concentrations.

P13L1-16: Interesting results and informative discussion

Table 1: citations for literature data should be provided

Figure 1: the 'automatic trigger' terminology seems a bit odd if the text just calls the component a 3-way valve

Figure 3: What is the basis for the expectation that beta CAs are the most abundant in soils? Provide citation or justification.

Figure 4: It is not clear which lines and points in Figure 4 correspond with LeBray1 soil versus an α CA addition of 24 mg L⁻¹, which are both stated in the caption. If the α CA data were plotted for some soils, wouldn't the kiso values be different? If they are not significantly different, as suggested in Fig 6, a justification for plotting results from the no-addition and addition should be given because that reasoning is not clear at the beginning of the results section. Would it be worthwhile switching the order of 3.1 and 3.2 or referencing 3.2 as justification?

Figure 5: May be useful to state why plotted without distinction (CA conc shouldn't affect result for water isotopic composition) and rest why CO₂ gas exchange results shift with depth (Eq xx)

Figure 6: difficult to see diamond points - shift CA concentration labels. Why are some LeBray2 points missing in 6b? What are the open circles representing? State in caption.

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