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Interactive comment on "Intra-aggregate CO_2 enrichment: a modelling approach for aerobic soils" *by* D. Schlotter and H. Schack-Kirchner

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This manuscript estimates maximum intra-aggregate CO_2 concentrations associated with aerobic respiration for both siliceous ("CO_2-H_2O") and calcaric ("$CaCO_3$-CO_2-H_2O") soil conditions. It determines dissolved carbon from the dissociation constants of the relevant chemical reactions assumed to occur within homogeneous, cylindrically shaped soil aggregates. The diameter and length of the aggregates, 4.8 and 9.2 mm, respectively, were chosen to minimize oxygen concentration within the aggregates without the existence of anaerobic zones. Respiration rates are non-homogeneous within aggregates, with maximum rates occurring near their surface and zero respiration in the central zone. Coupled inter-aggregate variation of CO_2 concentration is modelled assuming that transport is diffusive and total respiration varies exponentially

with depth. A soil surface respiration rate was imposed so that the total CO_2 flux was approximately $\times 10^{-6}$ mol m^{-2} s^{-1}, which is a typical field-measured rate. The authors conclude that storage of CO_2 within aggregates is too small to affect total storage calculated with simpler models that do not include detailed intra-aggregate processes. The presentation of this paper is excellent. Objectives are clearly stated with proper motivation, there is adequate informative literature review, the organization is sensible, and the writing is concise and focused. **I recommend publishing this paper as is.**

While this paper makes some novel contributions to our understanding of soil respiration I view it more as a starting point and inspiration for further work with regard to intra-aggregate processes. The authors objectives were focused on estimating maximum values of CO_2 concentration within aggregates. Therefore they simplified their analysis by, for example, assuming constant air-filled porosity both in both the inter-aggregate and intra-aggregate pore spaces. Furthermore the magnitude and variation with depth of total respiration production was imposed *a priori*. A more detailed and realistic approach would couple water and heat flow storage/transport equations to the CO_2 budget for both pore spaces. Such coupling has been previously carried out for the inter-aggregate scale but not within aggregates. Doing so in combination with such observations as reported by the authors that microbial mass and decomposition rate is higher in the outer part of aggregates should lead to a more complete understanding of respiration in soils. Many questions with regard to aggregate size and shape, inclusion of anaerobic zones, and coupling to, say, the nitrogen balance are in need of further study at the aggregate scale.

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