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Interactive comment on "Ideas and perspectives: Can we use the soil carbon saturation deficit to quantitatively assess the soil carbon storage potential, or should we explore other strategies?" *by* Pierre Barré et al.

Anonymous Referee #2

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The opinion paper "Ideas and perspectives: Can we use the soil carbon saturation deficit to quantitatively assess the soil carbon storage potential or should we explore other strategies" tackles an important question in relation to the role of soil carbon for climate mitigation. The question from policy makers need to be answered how much additional soil carbon could be stored and by with means. The paper is written and structured well but it remains partly superficial und may thus be even misleading.

In the introduction the terminology should be clearer and differentiate between "storage", "stocks" and "sequestration", "gain". "Storage" and "stocks" refer to a state vari-

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able in mass per unit area (here mass carbon). "Sequestration“ and "gain“ refer to a flux, here the carbon flux from the atmosphere to the soil as mass per unit area per unit time. Thus, the definition of a "C storage potential“ – the focuss of this paper - (l. 10) sould refer to a maximum stock which is independant of time and not a mixture of both, stocks and fluxes. Both variables are important in relation to climate mitigation options and the 4per1000 initiative. The C storage potential informs on the maximum cumulative sequestration with could be achieved (independant of the time) and the sequestration rates inform on the temporal dynamic of changing C stocks.

Several questions are asked in the second chapter of which the first one is the most important: In other words it is the question whether there is evidence for the existence of a maximum C storage potental of soil of the mineral associated C fraction. However, this question is not answered and the authors even do not try to compile evidence if the size of mineral surfaces limit soil C storage. By only refering to literature that found or assume a relation between mineral associated C stocks and mineral surface area experimental evidence is still missing whether the size of mineral surface area is the final limit for storage of stabilised C. New methods visualising soils at nano scale reveal that mineral surfaces are never completely covered with organic matter even in soils which were assumed to be C saturated.

I agree with the reviewer 1 that I do not see wide misuse of the term "C saturation“ since it was only used for mineral associated soil C. For sure other concenpts are required for the total soil carbon maximum storage potential. However, in order to progress on this way it sould be first discussed wether and why such a maximum storage potential exists for total soil carbon. Organic soils are the best example that soils can store almost unlimited amounts of carbon under certain environmental conditions (here water logging). If the so called "whole-soil OC storage potential“ is to inform on the contribution of soils and soil carbon for climate mitigation on a global scale, it might be much more relevant to discuss the limited C input to the soil as litter and rhizodeposits. The differences in soil carbon stocks between grasslands and croplands point to the fact

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that not the soils and their physical nature are limiting C stocks but the available C input that goes into the soil.

"New avenues to progess“ are promised (l. 9. P. 5) but I see little new ideas. The data driven approach (section 3.1) that explores national or international soil inventories is already used and published, e.g. by Beare et al. 2014 and other authors mentiond in the paper. Whether these approaches are appropriate or not, in particular if they should be applied to whole soil C storage potential estimates, remains unclear. In l. 20 p. 6 the problem is pointed out that saturated C soils may not be part of the data sets. In contrast, l. 31.-33 p. 6 the approach is judged as appropriate. This is inconsistent.

One major limitation of model driven aproaches are is not discussed: The mentioned models mainly translate the C input into equlilibrium C stocks. Unfortunately, the is very little information on the real C input to soils which maybe to large extend via roos, root deposits and root exudates. Without such knowledge on the C input, model drivend approaches are of limited robustness and results can be biased.

I appreciate that this paper starts an important discussion on scientifically sounds methods to extimate the potential role of soil C for climate mitigation. Unfortunately, I see major points not taken into account (see above).

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