

## ***Interactive comment on “Long-term bare fallow soil fractions reveal thermo-chemical properties controlling soil organic carbon dynamics” by Mathieu Chassé et al.***

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A sound manuscript that describes the physical size separation of archived soil samples from a long term bare fallow experiment in France, and the evaluation and characterisation of C within these fractions using a range of analytical techniques. The manuscript concludes that the majority of the SOC stocks have residence times ranging between years to decades, with the SOC being progressively transferred to finer fractions in the soil. Pyrogenic OC constituted the majority of the SOC pool that persisted over centennial time frames while the fine fraction of the SOC pool was shown to be in dynamic equilibrium. One technical aspect that the authors should address is

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with regards to the persistence of PyOM- there are some comparisons with the MRT using literature from biochar studies where the PyOM is well characterised and usually quite consistent (temperature, feedstock etc). Here the PyOM is from natural sources and could be highly varied with regards to these aspects, so the comparisons may not be valid. Also, the work does not consider the leaching of PyOM which has been shown in some studies to be an important loss pathway for PyOM from surface soils. Overall, the manuscript is very well written. The manuscript could be improved through the development of more comprehensive hypotheses and addressing these in the discussion. There are a handful of grammatical improvements that could also be made. A few minor specific comments are also provided.

28 it is not clear what is meant by distinct dynamics. This is rather broad and somewhat meaningless, so suggest that this aim be developed into a more comprehensive hypothesis. 29 mechanistic origin is also a rather loose term and could be improved. 2.3 the term ‘has been’ is used in the methods section. I would read this as other research that has been reported elsewhere. Suggest simply changing to ‘was.’ 2.4 Raman spectra (Renishaw in Via) were obtained on micrometre. ... Figures. Not clear whether the error bars represent +/- SD or span the SD. Fig 2. The separation between persistent C and total C are not that clear from the diagram- Suggest perhaps dashed lines to represent total C? 3.2 “In a matter of clarity” this sentence seems to be incomplete as it is not clear what is being clarified? Please reword. Fig 4. Consider whether this data would be better represented as a table as there are only a handful of data points. 4.1.3 Pyrogenic organic carbon exhibits contrasting dynamics. Also in this section, it would be beneficial to the reader if the authors could be more specific about the term ‘dynamics’- eg, with respect to what exactly. 4.1.3 line 25 ‘is less than”

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