EGU22-2603
https://doi.org/10.5194/egusphere-egu22-2603
EGU General Assembly 2022

NMR-spectroscopic virtual fractionation of soils mixed with pyrogenic carbon as a tool to separate chemical processes related to aging of pyrogenic carbon from those occurring during humification of soil organic matter

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Biochar has become an accepted soil amendment due to its potential to improve soil properties and as a tool to increase carbon sequestration. The latter is based on its relatively high biochemical recalcitrance augmenting the slow C pool after its addition to soils. However, newer studies indicated that the longevity of biochar and naturally produced pyrogenic organic matter (PyOM) in soils is lower than commonly assumed. Many of those studies are based on the determination of CO2 production changes or on the recovery of their isotopic labels in the soil after amendment of biochar or PyC incorporation. Most probably because of the lack of appropriate techniques to differentiate between the natural soil organic matter fraction and the added black carbon, only few reports are available which relate turn-over data with chemical alterations of biochar during aging or the impact of the latter on the quality of the total SOM pool. In order to fill this gap, we applied virtual fractionation of SOM into different organic matter pools by different solid-state NMR techniques. Whereas the most common combines the determination of turnover rates via stable isotope techniques, an alternative approach takes advantage of different relaxation behavior of biochar and humified SOM. In both cases spectra can be calculated that show either the added biochar or the respective SOM. In the frame of the present work, the concept and the potential of the two approaches will be explained by using examples studied in our laboratory. With this, we intend to provide a further powerful tool which can lead to a better understanding of the biochemistry related to the transformation of PyC and biochar during aging and their subsequent integration into the soil organic matter fraction.

Acknowledgement: Financial support has been provided by the European Institute of Innovation and Technology (EIT), a body of the European Union, under Horizon2020, the EU Framework Programme for Research and Innovation (Project 21217 Black to the future - biochar and compost as soil amendment)