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RESPONSE

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Response to: "The robust concept of mineral-associated organic matter saturation: A letter to Begill et al. (2023)"

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Here we respond to the comments of Cotrufo et al. in their letter to Begill et al. (2023) in a pont-by-point manner, using the same numbering as in their letter. We argue that the concept of mineral-associated organic carbon (MAOC) saturation is not robust and that none of the points raised by Cotrufo et al. can weaken the general findings of Begill et al. (2023).

1. Size fractionation with only two fractions will not yield completely homogeneous fractions. It was however found to be among the best methods to separate fast and slow cycling C pools (Poeplau et al., 2018). The way it is done now in many laboratories, following the suggestion of the authors themselves (Lavallee et al., 2020), will lead to a certain contamination of MAOC with fine particulate organic matter (POM) and also dissolved organic carbon. The same is true for Cotrufo et al. (2019), who used hexametaphosphate and 18 h bead shaking, being at least as disrupting as 1 min of mild ultrasonic. Observations of both studies matched perfectly (Figure 1a,b), indicating negligible methodological bias between them. It is true, that the few soils with outlying high MAOC C:N ratios also had the highest C contents in the fine fraction and potentially other outlying properties. Yet, their MAOC proportion was comparatively low (Figure 1c). Excluding those did not affect the soil organic carbon (SOC)–MAOC relationship (Figure 1d). Those linear relationships in our systematic sample selection imply that there was no POM contamination bias towards high SOC soils. It rather seems that part of the LUCAS dataset (Cotrufo et al., 2019) was somewhat biased: forest topsoils are likely to contain parts of the litter layer (especially high SOC samples), which would underestimate their MAOC proportion.
2. Indeed, bulk SOC contents >10% are only found under specific environmental conditions. It is important to study all kinds of soils for research questions of such a general nature. Figure 1c shows that gleysols (triangles) tended to contain less MAOC than the average. They were not dominating the high SOC soils and their exclusion did not affect the fit and message (Figure 1d).
3. Cotrufo et al. (2019) presented machine learning predictions for 9415 samples based on fractionation of 186 samples (2%). They interpret a sharp MAOC saturation limit of 47 g kg^{-1} because none of the fractionated soils had more and thus the algorithm could not predict values out of this range. It is however very unlikely that none of the remaining 98% would have more MAOC (Figure 1). MAOC contents of >80 g kg^{-1} were also found by other authors (Georgiou et al., 2022; Matus, 2021). Regarding Figure 1b in the response letter: several linear relationships (depending on texture) seem to be a better choice than one saturating to fit all (see Begill et al., 2023, figure 3).
4. We agree to what is stated here and used RockEval together with the PartySOC model (Cécillon et al., 2021) to predict the proportion of stable SOC for the same sample set and many more soils. The stable SOC pool was smaller than MAOC, but the relationship to SOC equally linear (Delahaie et al., 2023). It is thus important to recognize that the C sequestration potential of soil cannot be deduced solely from the size of the MAOC pool but requires a more holistic view on the plant–soil system.

CONFLICT OF INTEREST STATEMENT

The authors declare to have no competing interests.

This article is a Response to the Letter by Cotrufo et al, https://doi.org/10.1111/gcb.16921, which was related to the paper of Begill et al, https://doi.org/10.1111/gcb.16804.

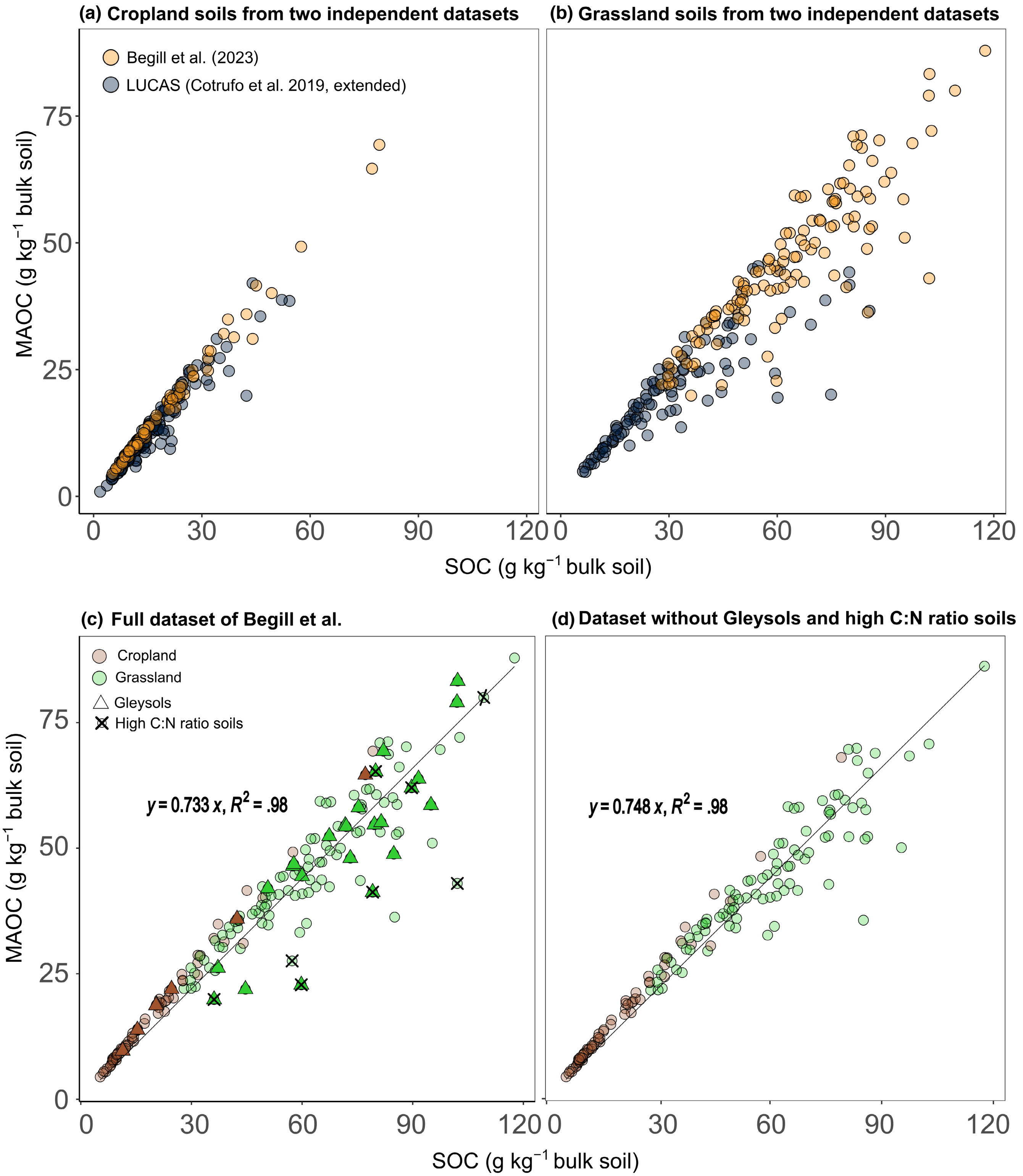

FIGURE 1 (a, b) Mineral-associated organic carbon (MAOC) content as a function of total soil organic carbon (SOC) content per land use from two different sources based on two different dispersion methods. Both datasets fit well together, indicating that differences in the study results (and their interpretations) are not related to methodological differences but rather to sample selection and overinterpretation of the machine learning results. Grassland soils show a higher scatter than cropland soils, but a general saturation behavior of the MAOC fraction is not visible for both land use types; (c) MAOC content as a function of total SOC content with regression equation as shown in Begill et al. (2023) but highlighting gleysols and high C:N ratio soils and (d) the same correlation after removing both gleysols and high C:N ratio soils. Both groups of soils indeed altered the scatter in the dataset but they tended to have rather lower MAOC proportions than the average. Removing all these soils did not influence the fit, as indicated by almost equal summary statistics. The general conclusions of Begill et al. (2023) are thus robust.

DATA AVAILABILITY STATEMENT

The data that were used in this study are openly available at https://doi.org/10.5281/zenodo.7966076 (Begill et al., 2023) and downloadable upon request from the European Soil Data Center at https://esdac.jrc.ec.europa.eu/content/soil-organic-matter-som-fractions (LUCAS).

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