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Interactive comment on "Proximal sensing for soil carbon accounting" *by* Jacqueline R. England and Raphael Armando Viscarra Rossel

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We thank the reviewer for the constructive comments on our submission. We have addressed all of the comments made. Our responses, indicating the revisions that we made, are preceded by 'Authors response:'.

Anonymous referee #2: The authors review the current state of proximal sensing for measuring soil organic C stocks and monitoring changes therein, subsequently discuss use of proximal sensors in support of new soil organic C accounting methodologies with linkages to national and international requirements for measurement, reporting and verification (e.g. UNCCD-LDN). Key literature and novel developments have been critically reviewed, showing that many of these studies still relate to 'proof-of-concepts'

rather than widely applicable solutions for widespread (and uniform) soil carbon accounting. With minor changes this review should be of wide interest to the readership of SOIL.

Authors response: We thank the referee for the positive comments on our work. We note that although some of the technologies and studies that we report on are still at the 'proof-of-concept' stage, our review suggests that currently, there sensing techniques that can be used for cost-efficient soil organic C accounting.

Anonymous referee #2 Comments:

p.2, line 9: soil organic matter should be: soil organic carbon

Authors response: Thank you, done.

p. 2, line 20: rephrase as "over periods longer than 5 to 10 years. . ."

Authors response: Thank you, done.

p. 3, line 2 and elsewhere: remove initials R.A. from citation

Authors response: Removed initials throughout, thanks for pointing this out, it was a problem with our .bib file.

p. 4, line 9: increases in net carbon stocks

Authors response: Thank you, done. Changed '...increases in C stocks...' to '...increases in net C stocks".

p. 4, line 11 to 35: This section/example could be incorporated in section in section 5.3. Further, whenever possible, reference should be made to similar initiatives/activities in other countries or continents.

Authors response: Thank you for the comment and suggestion. We preferred to leave the discussion of the Australian ERF in section 2 because we think it fits better there. Regarding the second part of the comment, we now elaborate on similar Canadian

schemes. As far as we know, there are no others.

p. 9, line 5: electromagnetic (a word is missing here, spectrum), are due to. . .

Authors response: Added '...spectrum'. Thank you.

p.9, 4.1.2: should also discuss recent innovations concerning new hand-held sensors (e.g. SoilCares and other groups), and their possible limitations, issues with calibration.

Authors response: We prefer not to mention specific commercial groups developing soil sensing services. Our review of spectroscopic sensing (section 4.1.2) covers the central and relevant aspects of the technologies around accuracy, rapidity, cost and practicality, and sections 5.1 and 5.2 include the requirements for developing spectral libraries and calibrations, respectively. Further, as far as we know, there are no such groups (e.g. Soil Cares) who are currently providing services for soil C accounting. Presently, most of these companies are targeting agronomic applications.

p. 9, 4.1.3: LIBS should be referred to as an emerging technique for estimating SOC.

Authors response: We prefer to remain impartial and only report the current state in our understanding. A lot of the testing with LIBS has been and is being done in the laboratory. Few studies report the development of systems for soil analysis by proximal sensing (i.e. in the field). The Bricklemyer et al. paper is one of the few, but we note that they report poor estimates of organic C (r2=0.22). From our review of the literature, we conclude that there are significant limitations that need to be overcome before LIBS may be considered as an 'emerging technology' for proximal soil organic C sensing (i.e. for sensing in the field, not in the lab). The limitations are: samples preparation is involved and time-consuming; sample representativeness needs to be carefully considered because only a tiny amount of soil is ablated, we only have very limited understanding of how LIBS performs under field conditions with soil that has variable water content, particle sizes, etc., and to estimate organic C, LIBS spectra need to be calibrated. We have emphasised and clarified these points in our revision

of section 4.13 and in the Final remarks.

p. 10, line 23: NaI (spell out in full, clarify)

Authors response: Done, thank you. Changed to '. . .scintillation detectors such as sodium iodide (NaI) detectors'.

p. 13, line 3: rephrase: to rapidly estimate (or predict) soil bulk density

Authors response: Done, thank you. Changed to '. . .rapidly estimate soil bulk density'.

p. 14, line 33: in situ; ex situ (add a space or -)

Authors response: Done, thank you.

p. 15, Table 3. Please note the double lines at top resp. bottom of some tables

Authors response: Removed double lines from tables.

p.16, Table 4: This table essentially should provide the crux of the review. The underpinning references should be provided here in a footnote.

Authors response: We have revised Table 4 to include a more informative caption describing the comparisons made and footnotes for the references used.

p. 19, line 12: an independent assessment (see typo)

Authors response: Done, thank you. Changed to '. . .independent assessment'.

p. 20, line5. . .was selected. . .was not used

Authors response: Done, thank you. Changed to '. . .was selected. . .' and to '. . .was not used. . .'

p.26, Section 6: This concluding section could be reworked into a number of concise, bullet points, focussing on aspects of practical applicability

Authors response: We revised our Final remarks so that they are more concise and

focused on practical applicability. However, we preferred not to use bullet points.

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