

Author responses and proposed revision.

We thank the reviewer for their remarks and suggestions. Below, our responses and proposed revisions are in blue text and preceded by **Authors:**.

Reviewer 1 remarks and our responses.

Remark 1: The paper is well-written and the analyses are rigorous. However, the method section is very long and difficult to follow for the non-specialist.

Authors: Thank you. We agree the methods are dense. We will clarify and synthesise where possible to improve readability and understandability.

Remark 2: I would recommend transferring parts to an annex. Is there any reason why the equations are not numbered anymore after equation 3?

Authors: Thank you. As noted above, we understand the methodology may be difficult for readers not familiar with these methods. We will keep the model structure, uncertainty propagation and essential assumptions in the main paper. Detailed transformations, modelling settings and diagnostic procedures will move to an Appendix. We will also improve Figure 2 so that it better identifies the input, output and uncertainty represented at each stage. We will number each equation.

Remark 3: Is there any reason why the equations are not numbered anymore after equation 3?

Authors: Thank you for noticing; we will number each equation.

Remark 4 (L392): Line 392 Is there any reason why you were not able to re-sample 4 out of 59 locations within an acceptable distance?

Authors: This was simply careless phrasing, and we apologise for that—all 59 sites were within approximately 2 m of the initial coring sites (most within 1 m). Five sites had to be re-identified using a global navigation system because the physical

sampling pegs were disturbed by animals. We will revise by simplifying and correcting the phrase to remove confusion.

Remark 5 (Figs 3, 4, 10, 11): What does the red dot refer to? Please explain in the caption.

Authors: The red dot refers to the township of Muresk and corresponds to the red dot on the map of Australia in the top right corner. We will state this in every caption where the symbol appears.

Remark 6 (Table 2 and all tables and figures): Abbreviations should be defined in the caption.

Authors: We agree. We will revise each caption so that it can be read independently. All abbreviations, symbols, units, colours and interval summaries will be defined at first use in each caption.

Remark 7 (Section 4.1): I miss a consideration on the practical application. To what extent is this rather complex analysis realistic for farm management? Is there any key indicator that the authors can recommend for practical purposes?

Authors: The research and workflow are intended for soil scientists, analysts or soil-information services, not for direct operation by a farm manager. Its practical outputs are field- or management-zone summaries of carbon pools, their credible intervals and the probability of a meaningful difference. We will not recommend one universal indicator. TOC describes organic stock, the POC-to-protected-carbon balance describes composition, ROC describes residual carbon, and TIC is needed when inorganic carbon contributes to the inventory. The relevant summary depends on the management question. In the discussion, we will add the data requirements, likely update frequency and scale for decisions.

Remark 8 (L674 and L692): What does ‘bulk soliTOC’?

Authors: Thank you for the question. We will replace the ambiguous phrase with

‘SolITOC measurements on unfractionated bulk soil’ and define it at first use.