Response to Reviewer #2:

Reviewer 2.1: I have carefully considered your responses to my comments raised during the review process. The revised version is scientifically stronger, especially regarding the discussion of ancient carbon sources and the environmental controls on organic carbon composition and age. In my view, most of the comments have been addressed satisfactorily. I also understand several of the choices you made in the revision, particularly where the scope of the manuscript and the structure of the database limited the level of detail that could reasonably be added. Nevertheless, a few points would benefit from further clarification before final acceptance.

Answer 2.1: Thank you kindly for taking the time to review our manuscript for the second time. Please find below our detailed answers to the individual points. Where possible, we have combined similar reviewer comments to provide a concise response.

R2.2: 1. Radiocarbon-dead and ancient organic carbon sources. The revised manuscript provides a more complete discussion of radiocarbon-dead or pre-aged carbon sources, including geogenic organic carbon, petrogenic carbon, lignite-derived material, kerogen-bearing lithologies etc. This addition responds well to my concern and improves the scientific robustness of the manuscript. However, the operational treatment of these sources in the database remains somewhat unclear. Since the manuscript is database-oriented, readers need to understand whether such influences are explicitly encoded in the database, inferred from contextual metadata, or only discussed qualitatively in the manuscript. Maybe a short clarification explaining how samples potentially affected by ancient carbon inputs are handled in the database. A simple qualitative “flag” or metadata field indicating possible geogenic, petrogenic, lignite-derived, old soil/sedimentary, or unknown ancient carbon influence would substantially improve transparency and data reusability.

2. Metadata and uncertainty associated with old carbon inputs. The revised discussion acknowledges that ancient carbon sources can strongly affect radiocarbon signatures and source interpretations. This is important, but users of the database would benefit from a clearer indication of how uncertainty is documented. Please specify whether uncertainty related to old carbon inputs is captured through sample-level metadata, site-level geological information, literature-based interpretation, or user interpretation after data extraction. Even if such information is not available for all samples, explicitly stating the current limitation would be valuable.

3. Environmental controls on organic carbon composition and age. The expanded discussion of environmental controls is appropriate and improves the manuscript. The revised version now better acknowledges the roles of climate, vegetation, soil development, lithology, erosion, geomorphology, and land-use history. This broader framing is scientifically sound and responds well to my request. However, it would be useful to clarify whether these controls are systematically included in the database as metadata fields, or whether they are mainly intended as interpretative factors for users. Distinguishing between first-order controls and context-dependent controls could also help readers apply the database more appropriately.

A.2.2: To make more clear what ISRaD provides and what it does not provide, we have added text to section 1 and 7.2.

L93ff: It is important to note that ISRaD is a repository of measurements rather than interpretations. The database captures core radiocarbon measurements and associated metadata as reported in the original publication. Users should be aware that various factors can complicate interpretation of radiocarbon data, including mixing of C sources, inputs from non-soil C sources, and methodological differences across studies. We encourage users to carefully consider these factors when drawing conclusions from data in ISRaD, and provide guidance on this in Section 7.2.

L586ff: Alongside these data submission considerations, users of ISRaD should also be aware of factors that can complicate the interpretation of compiled radiocarbon data. While a comprehensive treatment of radiocarbon interpretation is beyond the scope of this paper, detailed guidance is available elsewhere (e.g., Schuur et al., 2016). Here, we highlight considerations that are particularly relevant when working with compiled data from ISRaD. Several environmental variables, including mean annual temperature, mean annual precipitation, soil order, land cover type, and parent material, can be entered as site-level metadata in ISRaD. However, none of these are mandatory fields, and therefore, coverage is incomplete across entries. To overcome this shortage, the ISRaD R package provides a number of data enhancement tools (*ISRaD_extra* functions) that calculate or fill in certain fields with missing data, as well as provide ancillary data from various geospatial data sources that can help contextualize individual measurements.

Beyond environmental context, users should be aware of factors affecting the radiocarbon signal itself. Inputs of radiocarbon-dead C from geogenic sources, including petrogenic organic C from sedimentary parent materials, such as kerogen and lignite, as well as C-rich surficial deposits, such as loess, can substantially deplete soil ^{14}C signatures (Copard et al., 2025). Users are encouraged to consider these inputs when working with data from deep soils, soils formed in areas with significant aeolian inputs, and/or soils derived from C-rich parent materials. Though not available across all entries, data from radiocarbon in fractions and incubations specifically are intended to demonstrate that bulk radiocarbon data often represent mixtures of different-aged components, and this is one reason we highlight them in this update of ISRaD. In addition, although bulk layer data are entered under the assumption that inorganic C has been removed before analysis (Section 5.1), inorganic C from carbonates can still affect radiocarbon measurements from incubations and flux data, especially in calcareous soils, limed agricultural systems, or arid regions (Wang et al., 2026). Finally, methodological differences across studies, including variations in fractionation protocols, incubation conditions, and sample pretreatments, can introduce systematic differences in measured ^{14}C values, complicating cross-study comparisons.

R2.3: 4. Classification of mangroves, salt marshes, and tidal wetlands. The clarification of coastal vegetated environments is useful, but I think this point remains only partially resolved. Mangroves, salt marshes, and tidal wetlands differ substantially in vegetation type, organic matter production, sediment trapping efficiency, hydrodynamic setting, salinity regime, and carbon preservation potential. Grouping them too broadly could reduce the interpretative value of the database. Please make the classification of mangroves, salt marshes, and tidal wetlands more explicit. If they are grouped under a broader coastal wetland category, the manuscript should clearly state which metadata fields allow users to distinguish between these environments.

A.2.3: We have made the following additions to the manuscript:

L479ff: In addition, users should note that coastal wetland environments, including mangroves and salt marshes, are currently grouped under the broader wetland land-cover category in ISRaD. No dedicated metadata field allows systematic filtering by wetland type. Since these environments differ substantially in vegetation, organic matter production, and C preservation potential, data users may have to determine further distinctions through site-level description fields and geographic location. Improved classification of coastal wetland types is a recognized limitation and a priority for future versions of ISRaD.

R2.6: 5. Database governance, versioning, and long-term maintenance. The manuscript would benefit from a more explicit statement on database sustainability. For a data paper, long-term usability depends not only on the current dataset, but also on version control, update procedures, quality control, and citation practices. If possible, the addition of a short paragraph describing whether future updates are planned, how quality control will be maintained, and how users should cite specific versions of the database could be useful.

A.2.6: Done. We add the following text to the manuscript:

L595ff: ISRaD data are released and archived periodically following major structural changes or after ingestion of a substantial amount of new data. Each official release is assigned a DOI and archived on Zenodo to facilitate reproducibility of analyses. Versioning follows a three-tiered sequential numeric identifier in the form of major.minor.patch, accompanied by the date of the most recent change (ISRaD v2.9.9.2025-08-14 for example). All changes to data and code are maintained under version control and are immediately available through the ISRaD GitHub repository. New data entries must pass an automated QA/QC check, which can be initiated via the ISRaD R package or directly from the ISRaD website, before submission (as previously described in Lawrence et al. 2020). Entries that pass automated QA/QC are then subject to expert review to ensure proper completion of more complex aspects of the template, such as classification of soil fractionation methods. Only entries that pass both automated and expert review are ingested into the database. To ensure repeatability of analyses and accurate attribution, users should always record both the full version number and the date when accessing ISRaD data, and cite both this publication and the specific data release used in their work. If users leverage individual data entries from the database, they should also cite the original source dataset or paper. Finally, we strongly encourage users who interpret their own data in the context of data accessed from ISRaD to submit those new data for inclusion in ISRaD after they have published their results or have obtained a DOI for their dataset.

other minor points:

R2.7: Please ensure consistent use of terms such as “radiocarbon-dead carbon”, “ancient carbon”, “geogenic organic carbon”, “petrogenic organic carbon”, and “pre-aged organic matter”.

A.2.7: We have carefully reviewed the manuscript for consistency in terminology. Throughout the manuscript, we use 'radiocarbon-dead C' as the primary term to refer to C with no measurable 14C activity. More specific terms, such as 'geogenic organic C', 'petrogenic organic C', or ‘pre-aged organic matter’ are retained where they refer to a specific source of radiocarbon-dead C.

R2.8: A final language check would be useful in the sections discussing carbon source terminology and coastal wetland classification.

A.2.8: We have done a careful language check, and inconsistencies have been corrected.

R2.9: Please make clear when a limitation reflects incomplete metadata availability rather than a conceptual limitation of the framework.

A.2.9: Done. The distinction between metadata availability limitations and conceptual limitations of the framework is addressed throughout our responses to points 2.2 above, as well as in the revised manuscript text.

R2.10: Overall, the revision is satisfactory and the manuscript has improved substantially. The authors have addressed the main scientific concerns the remaining issues are mostly matters of clarification and database transparency rather than fundamental scientific weaknesses. I would support publication after minor clarifications addressing the points above.

A.2.10: We hope that our detailed responses have addressed all outstanding points.