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Seasonal dynamics of dissolved organic matter along an intertidal gradient in semi-arid mangrove soils (New Caledonia)

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Response to Reviewers

Reviewers' comments:

RC #1:

General comments

This paper explores the dynamics of dissolved organic matter (DOM) in a semi-arid mangrove of New Caledonia, along a land-sea transect through three habitats during two characteristic seasons (dry, and warm and wet). The field and lab work were considerable, and the study gives many results on various parameters, such as pH, salinity, redox potential, as well as optical properties of the DOM. It identifies two main controlling factors for the DOM dynamics: the first is the habitat (characterized in this case by the distance to the sea and the vegetation), and the second is the season.

The paper stresses the need for more work on this specific type of mangroves, which are less studied than humid tropical mangroves despite their specificities. Thus, it raises many questions and needs for further research, especially to improve the knowledge on the origin of the OM. It was overall very nice to read, although some indices should be introduced more clearly to help the reader interpret the results.

We sincerely thank Anonymous Referee #1 for their time and constructive feedback, which have helped improve our manuscript. We have carefully considered all comments and revised the manuscript accordingly in the revised version.

Regarding the comment on the introduction of some indices, we agree that clearer explanations will improve the readability and accessibility of the manuscript. In the revised version, we will provide clearer definitions of the optical indices used in the Methods section to better guide readers in understanding their significance.

Specific comments

L.137: how did you know the reaction was complete?

We thank the reviewer for this relevant comment. The reaction was considered complete when no visible effervescence was observed after successive additions of H_2O_2, suggesting that the majority of reactive organic matter had been oxidized. We have clarifed this point in the revised manuscript L. 140 by adding *'was gradually added per beaker until no further effervescence was observed'*. A color change in the sample was also observed to complete the previous observation.

L.160: just to clarify, for TOC measurements, you only measured one core per site (same one used for XRD), that's right?

We thank the reviewer for this clarification request. TOC analyses were performed on all collected cores (three per site), not only on the core used for XRD analysis. The sentence aimed to indicate that the same preparation procedure was applied, *i.e.*, dried and ground samples, as for XRD measurements. We clarified this point in the revised manuscript to avoid any misunderstanding by adding L. 165: '*The same dried and ground samples prepared for XRD were used for TOC analysis. We also dried and grounded samples from the two other cores to complete our triplicates sample set*'.

L.171: we could use a definition of E2 and E3. Same for 'SUVA': what does it mean? More generally, when you introduce indices, you could give their range and meaning of extreme values (as you did for HIX).

We thank the reviewer for this helpful comment. We agree that clearer definitions and interpretation ranges of the optical indices will improve the readability of the manuscript. In the revised version, we have defined E_2/E_3 as the ratio of absorbance at 250 nm to 365 nm, and $SUVA_{254}$ as the specific UV absorbance at 254 nm normalized to DOC concentration. We also clarified the interpretation of high and low values for each index, as indicators of molecular weight, aromaticity, and humification degree, similarly to what was done for HIX. We added to L. 189: *'Higher value of E_2/E_3 suggest lower molecular weight and lower aromaticity. The Specific UV Absorbance ($SUVA_{254}$), a proxy for aromaticity and humification is calculated as the ratio of absorbance at 254 nm to the concentration of DOC. A higher $SUVA_{254}$ value is associated with more aromatic and humified CDOM.'*

L.187: I don't fully understand the difference between what is given by PARAFAC and what is given by CORCONDIA. But it may not be of significant importance for the understanding of the paper.

We thank the reviewer for this helpful comment. We improved our explanation in the revised version to clarify the distinction between the two approaches. PARAFAC was used to decompose the EEM dataset into independent fluorescent components, whereas CORCONDIA (Core Consistency Diagnostic) was applied to validate the appropriate number of components and assess the robustness of the model. We clarified this distinction in the revised manuscript to improve methodological clarity L. 205: *'The optimal number of components in the PARAFAC model was validated using the CORCONDIA (CORe CONsistency DIAgnostic) algorithm, with values exceeding 60% considered optimal (Zhao, 2011).'*

L.224: how is land-derived OM brought to the salt-flat, as there is not vegetation on it and you state L.96 that Bouraké is "unaffected by external terrigenous sediments and organic inputs, with no direct freshwater input from rivers"? Is it only OM coming from the soil organisms, and not vegetation? Or maybe I am misunderstanding something here.

We agree that the term "land-derived OM" may have been misleading in this context. The Bouraké site is indeed not influenced by external terrigenous or riverine inputs. In this study, "land-derived OM" refers to organic matter produced locally within the upper intertidal zone, including soil microbial production, benthic biofilms, and organic matter stored in substrate, rather than external continental inputs. We clarified this formulation in the revised manuscript to avoid any misunderstanding. We replaced "land-derived OM" by *'soil-derived OM (C1)".*

L.229: in the caption of Figure 2, you could add a word on how to interpret the names of your samples, as you display them on the graph. I guess the beginning stands for Season-Habitat-, then -Depth-Core or -Core-Depth? Also, on the figure, we don't know yet what a254, a350, a442 stand for: it is only introduced (and only for a350) in L.309: perhaps you could explain it now, or maybe say it will be detailed in section 3.4.

Thank you for this helpful comment. We agree that additional clarification in the figure caption will improve readability. In the revised version, we have specified how sample names are structured (Season [W or D] - Habitat [Sa, Av or Rh] - Core replicate [1, 2 or 3] - Depth [a, b or c]) to facilitate interpretation of the PCA plot.

We also added a word on the a254, a350 and a442: *"Absorption coefficients a254, a350, and a442 correspond to CDOM absorption (m^{-1}) at 254, 350, and 442 nm, respectively. Sample codes follow the structure Season-Habitat-Core replicate-Depth (e.g., W-Sa-1-a corresponds to Wet season, Salt-flat, core 1, surface layer)."*

L.259: I think you inverted the seasons: "62.9 ± 1.2% during the dry season vs. 60.7 ± 2.4% during the wet season" --> 62.9 is wet season and 60.7 is dry season, I guess?

We thank the reviewer for this observation. We have carefully rechecked our dataset, and the reported values are correct: the mean water content in *R. stylosa* soils is 60.7% during the wet season and 62.9% during the dry season. These values are presented in Figure 4 and in Appendix Table A3. In semi-arid climate, *R. stylosa* develop at the lowest elevation in the intertidal zone, and in their thus immerged at all tides. The relatively stable water content between seasons in this habitat likely reflects the near-permanent tidal inundation of this zone whatever the season, which maintains consistently high soil moisture regardless of seasonal rainfall variations.

L.311: as already said for the Material & Methods L.171, we need more information in the text to understand the results regarding S275-295, E2/E3 and SUVA: what are the min and max values these indices can reach by definition? What do they mean?

We agree that additional information would help readers interpret the reported values of $S_{275-295}$, E_2/E_3, and SUVA. We added this information in the method section in the revised manuscript (L. 189-192) to clarify the definition and interpretation of these indices. Although these indices do not have strict theoretical minimum or maximum values, their variations are commonly interpreted in terms of DOM molecular weight, aromaticity, and degree of humification. In the revised manuscript, we provided typical ranges reported in the literature, in order to facilitate interpretation of our results. L173*: "Previous studies have reported S275-295 values in the range of 0.010-0.020 nm-1 for coastal waters respectively and 0.014-0.018 nm-1 for wetlands (Hansen et al., 2016; Helms et al. 2008)."*

L178: *"A higher $SUVA_{254}$ value is associated with more aromatic and humified CDOM. For example, $SUVA_{254}$ values for plant leachates typically range from 2.9 to 4.1 L mg-C^{-1} m^{-1}, whereas algae-derived DOM generally shows lower SUVA254 values around 1.7 L mg-C^{-1} m^{-1} (Hansen et al., 2016)."*

L.336: is the photodegradation signal (C4) identical regardless of the origin of the OM that is degraded (terrestrial, mangrove, marine)?

We thank the reviewer for this relevant comment. Indeed, the C4 component is interpreted as a photodegradation-related signal; however, it does not allow us to determine the original source of the degraded organic matter (terrestrial, mangrove-derived, or marine). It rather reflects a transformation process affecting DOM, independently of its initial origin.

L.342: how do you explain the absence of changes in C3 (marine humic-like fluorescence) between habitats? One would expect it to be higher in R. stylosa > A. marina > salt-flat.

We thank the reviewer for this comment. Although C3 is commonly described as a marine humic-like component, our results show no clear spatial gradient across habitats, suggesting that this signal may be largely homogenized along the transect by tidal exchange and mixing, or may reflect a broadly distributed background pool of marine humic-like DOM rather than a habitat-specific source.

In addition, similar fluorescence signals have been described as "microbially derived matter" (Hong et al., 2021), as "microbial origin" (Wauthy et al., 2018), or associated with "marine environments with biological activity" (Smith et al., 2021). These similarity with our C3 component and literature are presented in Table A5. Therefore, component C3 may also arise from *in situ* microbial processing of DOM, which could contribute across habitats depending on local environmental conditions.

The significant increase of C3 in the *A. marina* stand during the wet season may reflect enhanced DOM production and mobilization under warmer and wetter conditions (e.g., increased microbial activity and leaching/solubilization), leading to a higher contribution of humic-like fluorophores in this habitat during that season. As described in the manuscript L549-555.

L.399: You stated in your Methods section that 'HIX values ranged from 0 to 1, with higher values reflecting a greater degree of humification', but you are now displaying 'HIX > 30'. Maybe HIX and BIX got mixed up?

We thank the reviewer for pointing out this point. The statement in the Methods section indicating that HIX ranges from 0 to 1 was incorrect and was corrected in the revised manuscript (L. 212-123). Higher HIX values indicate a greater degree of humification, and values may exceed 1. We confirm that HIX and BIX were not mixed up in the Results section. The Methods description was revised accordingly.

The sentence was modified as follows: "Higher HIX values indicate a greater degree of humification and DOM maturation and values <4 are associated with less humified DOM (Luz-Santos et al., 2025)."

L.409: you suggest that a lot of photodegradation happens in the salt-flat: shouldn't this lead to a higher C4 signal?

We thank the reviewer for raising this very interesting point. To explain the strong humification of DOM observed in the salt-flat, we initially proposed several degradation processes that could lead to the formation of highly transformed and humified DOM, as reflected by the C1 component. However, we acknowledge that the C4 component is described in the literature as being associated with photodegradation processes, and is often referred to as a "photo-product" (Hong et al., 2021; Amaral et al., 2020; Chen et al., 2017; Lambert et al., 2016).

Nevertheless, C4, which has spectral characteristics distinct from C1, does not appear to be more abundant in the salt-flat and shows relatively homogeneous contributions across the three habitats along the intertidal gradient. Although the highly humified C1 component may partly result from solar degradation processes, given the strong exposure of this habitat to solar radiation, we agree that this hypothesis should be considered with caution. Other processes may also contribute to the transformation and humification of DOM.

We therefore revised the manuscript to present the potential role of photodegradation in the formation of C1 more cautiously, and acknowledge that additional processes may also contribute to the production of this highly humified DOM (L416).

L.484: so, C1 and C4 would both indicate photodegradation?

We thank the reviewer for highlighting this potential ambiguity. C1 and C4 do not indicate the same information. C4 is interpreted as a photodegradation-related component (Table A5), whereas C1 corresponds to a humic-like, highly transformed DOM pool (i.e., a more "mature"/humified signature). Photodegradation may contribute to the formation of such humified material, especially in the highly exposed salt-flat, but other processes (such as microbial processing and selective preservation/accumulation) may also contribute. We revised the text to avoid implying that C1 and C4 both directly trace photodegradation. L504: "*Taken together, these patterns suggest that: i) C1 likely reflects highly transformed DOM pool of humic substances; ii) C2 is associated with mangrove-derived OM; iii) C3 indicates microbial activity; and iv) C4 corresponds to photo-degradation but lacks spatial variability.*"

Technical corrections

L.171: you can add comas for better clarity: 'The SUVA, a proxy for aromaticity and humification, is calculated as […]'.

Thank you for this suggestion. The comma was added L. 190 in the revised manuscript for clarity.

L.468: typo in 'adsorbion'

It was corrected in the revised manuscript (L. 517).

L.583 : 'regulated'

The wording was corrected in the revised manuscript.