RESPONSE TO REVIEWERS' COMMENTS

Regular font: original comment by the reviewer
Italized text: response by the authors
"Italicized quotes": revised text segments

Response to Comments by Referee #2

Comment: LaCroix et al. report findings on C storage and changes in the physical-geochemical composition of soils minerals and redox conditions under the seasonal flooding soils. Nevertheless, in different part of the manuscript several strongly weak points have been identified that must be addressed from the authors. Moreover, I do not find that results provided insight into the mechanism on C storage and the changes in the shifting minerals and other critical factors.

Authors' response: *We thank the reviewer for taking the time to review out manuscript and believe we adequately addressed the specific concerns mentioned below.*

Comment: 1. Synchrotron-based X-ray analyses and FT-ICR-MS analyses. There are plenty of literatures on these methods, as a reviewer also a reader, I suggest simplify these parts and move the detail descriptions into SI.

Authors' response: *We agree that the finer details of the methods for these sections should be moved to the SI. However, Biogeosciences allows for detailed methods sections. In the interest of providing sufficient information to less informed readers, we would like keep the level of details in the methods section as is.*

Comment: 2. Results. In figure 2, the symbols are too small and similar to be recognized, while and the resolution are lower.

Authors' response: *We have updated figure 2 to include color to differentiate the different positions and depths, and to be more legible in general.*

Comment: 3. In 3.3, compared with Feo and Alo, the authors haven't presented the detailed data of Fed and Ald, which are more sensitive to the changing of environmental factors. Meanwhile, the soil iron cycling is sensitive to the seasonal flooding, the recrystalliza- tion processes of iron oxides as well as aluminum oxides during the shifting of seasonal flooding soils are critical factors to the variation of the iron/aluminum species, which are further controlled the reactivity of iron/aluminum species in soil environment.

Authors' response: *As discussed in the initial manuscript (Page 12 Ln13-14), the dithionite-extractable Fe and Al data is well correlated with the amount of oxalate-extractable Fe. In other words, the trends are the same. We thus believe that adding the dithionite extraction data to the main manuscript has no added values and left them in the SI.*

Comment: 4. In 3.4, carboxylic/aromatic C ratios is a suitable indicator to present the different of oxidation degrees, however, from fig 5b, it's inaccurate to describe the increase trends of those values above in C horizons. It doesn't present significant different in fig 5b.

Authors' response: We changed the text to reflect that these differences are not significant at the $p < -0.05$ values, but maintain that the trends are ecologically ecologically relevant and worthy of discussion. We would also like to note that this is one of the first manuscripts that reports variability in analyses such as C NEXAFS and FTICRMS. Due to the low throughput of these analyses, replicates are generally pooled before analysis and only analyzed as a composite sample in other publications, leaving the reader with no sense of the variability.*

Author changes: "Though not statistically significant, the ratio gradually decreased across the upland to lowland transects in the topsoils (ANOVA, Table S4). In the subsoil, the opposite trend was observed, and the ratio increased from the upland C horizons to the lowland Cg horizons (Table S4)."

Comment: 5. In discussion part, the authors just repeated the obtained results described in results part in another similar way, lacking of further discussion around the mechanism among C storage and the changes in the shifting minerals and other critical factors. As a reader, I find it's hard to get new information in this important parts.

Authors' response: In response to this concern, we substantially revised the discussion sections to add information regarding the mechanisms under consideration. In particular, we revised section 4.1 and 4.3.

Comment: 6. Further experiments should be designed and conducted to illustrate the mechanism on soil chemical-physical properties and C storage.

Authors' response: We believe that in-field measurements and analysis of field samples along environmental gradients is a suitable tool to examine the effects of different soil properties on soil carbon. While we acknowledge that this approach is based on correlations, and mechanisms can thus merely be inferred, it is one that is widely used in the biogeosciences community (Angst et al., 2018; Barcellos et al., 2018;Chen et al., 2017; Hall et al., 2016, Hall & Silver 2015; Olshansky et al., 2018; Torn et al. 1997). We believe this study uniquely combines environmental data with soil physical-chemical properties to infer variations in C storage mechanisms across upland-to-lowland transects.

Full references:

Angst, G., Messinger, J., Greiner, M., Häusler, W., Hertel, D., Kirfel, K., Kögel-Knabner, I., Leuschner, C., Rethemeyer, J. and Mueller, C. W.: Soil organic carbon stocks in topsoil and subsoil controlled by parent material, carbon input in the rhizosphere, and microbial-derived compounds, Soil Biology and Biochemistry, 122, 19–30, doi:10.1016/j.soilbio.2018.03.026, 2018.

Barcellos, D., O'Connell, C., Silver, W., Meile, C. and Thompson, A.: Hot Spots and Hot Moments of Soil Moisture Explain Fluctuations in Iron and Carbon Cycling in a Humid Tropical Forest Soil, Soil Systems, 2(4), 59, doi:10.3390/soilsystems2040059, 2018.

Chen, C., Kukkadapu, R. K., Lazareva, O. and Sparks, D. L.: Solid-Phase Fe Speciation along the Vertical Redox Gradients in Floodplains using XAS and Mössbauer Spectroscopies, Environmental Science & Technology, 51(14), 7903–7912, doi:10.1021/acs.est.7b00700, 2017.

Hall, S. J. and Silver, W. L.: Reducing conditions, reactive metals, and their interactions can explain spatial patterns of surface soil carbon in a humid tropical forest, Biogeochemistry, 125(2), 149–165, doi:10.1007/s10533-015-0120-5, 2015.

Hall, S. J., Liptzin, D., Buss, H. L., DeAngelis, K. and Silver, W. L.: Drivers and patterns of iron redox cycling from surface to bedrock in a deep tropical forest soil: a new conceptual model, Biogeochemistry, 130(1–2), 177–190, doi:10.1007/s10533-016-0251-3, 2016.

Olshansky, Y., Root, R. A. and Chorover, J.: Wet–dry cycles impact DOM retention in subsurface soils, Biogeosciences, 15(3), 821–832, doi:10.5194/bg-15-821-2018, 2018.

Torn, M. S., Trumbore, S. E., Chadwick, O. A., Vitousek, P. M. and Hendricks, D. M.: Mineral control of soil organic carbon storage and turnover, Nature, 389(6647), 170–173, doi:10.1038/38260, 1997.