

The manuscript entitled “Ecosystem-specific patterns and drivers of global reactive iron mineral-associated organic carbon” discussed the spatial variability and characteristics of Fe-OC among continental, wetland and marine ecosystems and its governing factors globally. In this study, they highlighted the importance of reactive Fe oxides in global SOC preservation, and their controlling factors were ecosystem-specific. It is an interesting topic that should fit the scope of the journal. However, minor revision would be needed before a possible consideration of acceptance.

Major comments:

1. The author suggested that Fe-OC/Fed molar ratios less than 1 indicating an Fe-OC bonding form of monolayer surface sorption, and greater than 6 indicating a bonding mechanism dominated by coprecipitation in Line 98-101. So what does the Fe-OC/Fed molar ratio between 1 and 6 mean? Please provide references.
2. Line 153-155: Is the mean annual air temperature extracted from the WordClim database was taken in the same year as the sample collection? Please add something here.
3. Line 164-167: Why did you represent “treatment” and “control” in this way in the manuscript?
4. There are some ambiguous sentences in the manuscript. For example, 1) Since marine ecosystems do not have soil pH, the descriptions may be ambiguous in Line 208-210; 2) “The molar ratio of Fe-OC/Fe_d was positively correlated with Fe-OC and *f*Fe-OC in three ecosystem types, except for *f*Fe-OC in wetlands (Figs. 3e, m).” in Line 224-226. Check other places as well.
5. *f*Fe-OC was significant differences between wetlands and marine ($p < 0.001$) and continent ($p < 0.05$) in Fig. 2b. Why were no significant difference observed in Line 197? However, the authors concluded that significant difference in *f*Fe-OC was observed among different ecosystem types in discussion in Line 281-282. Please specify.
6. How did you estimate the data for SOC storage was bound to Fe oxides in different ecosystems in Line 288-292? Could you provide some calculation process to support this point of view?
7. Line 345-348: To further clarify the complexation of Fe with OC under reducing conditions. Please add the following references:
Patzner M S, Kainz N, Lundin E, et al. Seasonal fluctuations in iron cycling in thawing permafrost peatlands[J]. Environmental science & technology, 2022, 56(7): 4620-4631.
8. Line 338-339: “....., with <1 suggesting that the OC-Fe bonding form is dominated by simple mono-layer adsorption, while higher ratios indicating coprecipitation.” This sentence is confusing. Was the higher ratio >1 or >6 in this sentence? However, you showed that the molar ratio >6 , indicating a bonding mechanism dominated by coprecipitation in the introduction. Please specify.

9. Line 418-428: It would have been more intuitive to have a table with comparisons to previous studies.
10. Figure 7: 1) What do the different coloured triangles and squares represent? 2) There are some symbols and labelling errors. For example, “Sea” should be “marine”; “ f Fe-OC” should be “ f Fe-OC”; 3) Wetlands are not a transitional phase between continent and marine, they are more like a terrestrial ecosystem, so why show them in the middle of continent and marine? Please check other places as well.

Minor comments:

1. Line 15: Fe-associated organic carbon should be abbreviated as OC-Fe not Fe-OC. It should be changed throughout the paper.
2. Please standardize the unit format. For example, “g/kg” (Line 21) should be changed to “g kg⁻¹”, and the formatting of the units in the article (e.g., mg g⁻¹) and in the pictures (e.g., mg/g) was inconsistent.
3. Please check the format of “Fe-OC/dithionite-extractable Fe (Fe_d)” (e.g., Line 23) and “Fe-OC:Fe_d” (e.g., Line 26).
4. Line 26: Abbreviation for Random Forest.
5. The f Fe-OC was repeated in Lines 60 and 75. In addition, the explanation of f Fe-OC should be advanced in Line 75.
6. Line 86. Mean annual temperature modified to mean annual air temperature. MAT modified to MAAT. It should be changed throughout the paper.
7. Line 151, Table S1 is not in your manuscript.
8. Line 155: “version” should be “v”. In addition, the web address should be added. Check other places as well.
9. Line 222: “Fig. 3O” should be “Fig. 3o”.
10. There are many formatting errors, such as the space between a number and a symbol on page 15, Line 287. Please check other places as well.
11. Line 338: Here, it’s OC-Fe. Please standardise usage in the manuscript.
12. The letter case of figures in the manuscript should be resized.
13. Figure 2: 1) What does the legends (e.g., a, b, and c) mean? 2) Panels (a), (b), (c), (d), (e), and (f) were shown on different pages. Check other places as well.
14. Figure 3 needs to be re-optimized. For example, R , p and the image overlap. Check other places as well.