Response to Anonymous Referee #1

We thank the reviewer for the constructive review. Our responses to their comments are in red below.

The paper is well-written and the idea is ueful for the community. however, there are some doubts about reliability of the new proposed index which require more debates statistically. Here are my comments:

RABD670: There is a review from Van Exem et al. 2022 which they reviewed all the chl indices and they found out that RABAs work better than RABDs. Have you tried to implement that and compare the results since it seems to be possible with your data.

We did test RABA (relative absorption band area) indices, and found that the correlations between RABA indices and pigment measurements were slightly lower than the RABD indices we selected. We expect that the RABA indices are more affected by the overlapping absorption of chlorophyll-*a* pigments and Bchl-*c, -d, -e* pigments, and indeed we see that $RABA_{640\text{-}695}$ is significantly correlated with isorenieratene, suggesting an influence of overlapping pigments from GSB. For these reasons, we chose to proceed with the selected RABD indices. The comparison of RABA vs RABD indices was already shown in Fig. S1. We will include the correlation values used to generate this figure in a table in the supplement so that readers can see the precise values. We also note that the Van Exem et al. study presents results from one site and it is not clear if RABA indices work better than RABD indices at all sites.

Line 160: how did you determine the percentage reflectance values to remove cracks and mineral reflections? it seems it is based on practical excercise on your core and your hyperspectral scanner which it should be noted in the text.

Yes, this was done by some experimentation to achieve satisfactory results based on the data from our cores. These thresholds might not be relevant for other cores or scanners.

Fig 2: since RABD710-730 is located in the right shoulder of chl-a and phaephytin-a absorption bands, how would they effect this index? with bigger amount of chl-a and Phae-a it is expected that GSB-related signal disapear. And based on your data was there any detection limitation on this index?

Yes, there can be an influence of Chl-*a* and pheophytin-*a* on the $RABD_{710\text{-}730max}$ index. We have attempted to limit this influence by defining the trough to be from 695-765 nm, which, by having the start point on the slope of the absorption of Chl-*a,* limits the influence of Chl-*a* on the $RABD_{710\text{-}730max}$ value. Using this formula, there is likely to be a slight bias towards lower $RABD_{710\text{-}730max}$ values when Chl-*a* concentrations are high. We considered other formulations with wider trough endpoints (640-765 nm), however this version of the index is more strongly correlated with RABD670, indicating a greater influence of Chl-*a,* where the $RABD_{710\text{-}730max}$ is increased by high amounts of Chl-*a*. We did not attempt to formally calculate a detection limit because of the challenge of assessing all possible pigments that could be contributing to this index. We suggest that a greater number of pigment samples should be processed, and a more thorough determination of GSB pigment compounds would also be necessary to determine a robust detection limit. However, a comment below stimulated a rough calculation of a detection limit, see below.

Fig3: It would be better to remake all the plots in a way that the whole dots and the range are observed.

We will implement the suggested change.

Fig 3C: There are some RABD710-730 dots which are valued less than one, how do you interpret them?

RABD values less than 1 indicate that spectral profile is convex over the interval specified by the index. This is controlled by the reflective properties of the sediment. While RABD = 1 has been interpreted as generally indicating no absorption of the substance of interest, if the sediment has a convex spectral profile in the absence of any pigment, then a small amount of pigment could yield an RABD value of less than one. As a thought experiment, imagine that a sediment with no pigments has an RABD of 0.95, then adding some detectable amount of pigment to the same sediment might produce an RABD of 0.98. Therefore, we don't interpret RABD values less than 1 any differently than other RABD values. In the example of RABD710-730, a convex shape is likely to occur over the interval defined by the index in part due to the shape of the right side of the absorbance trough of Chl-*a*, which does have a convex shape. Additionally, several mineral components can also have a convex reflectance profiles over this interval (Kokaly et al., 2017).

Moreover, considering RABD710-730, I am curios to see what correlation you will get if you remove Isorenieratene which have big values (over 1000) and then recalculate the correaltion. It seems the correlation for the samples with Iso under 1000 are weak. Maybe, it can be discussed in terms of limitations of the index!

Regarding the correlation of isorenieratene and RABD710-730 – removing all data points with isorenieratene measurements greater than 1000 area/g yields an insignificant correlation, however, this is based on only 8 data points. We find that the correlation remains significant at $p < 0.05$ if we remove the 4 greatest values (>3000 area/g), leaving $n = 17$ samples. If we remove more samples, the correlation is weakened and no longer significant. This suggests a conservative detection limit around RABD710-730 = 1.036 (the highest RABD value of the lowest 17 samples), though a greater number of samples might clarify this point. We will mention this in the text to indicate that there is greater uncertainty at lower values, and that variations in the RABD index below about 1.036 should be interpreted cautiously, or considered below the limit of detection.

Fig4: this figure is a bit unclear. suggest to change the caption and specify y-axes is related to which RABD.

We agree with the suggestion, and will modify the figure and caption to make it more clear which data corresponds to which axis.

Finally, it is always a question that a model or here an index which is applied on one core can be applied on any other cores? what would be the limitations and maybe a discussion on this in the paper would be useful for reader.

We expect that newly developed RABD710-730 index can be applied to other sediments with high amounts of GSB-pigments. Ongoing unpublished work on Soppensee and other lakes confirms these initial results. Most likely the biggest limitation is the concentration of GSB-related bacteriopheopigments; it may be relatively rare to reach high enough concentrations in sediments for the HSI method to be able to robustly detect these pigments. We will include this in the revised discussion.

References

Kokaly, R.F., Clark, R.N., Swayze, G.A., Livo, K.E., Hoefen, T.M., Pearson, N.C., Wise, R.A., Benzel, W.M., Lowers, H.A., Driscoll, R.L., and Klein, A.J., 2017, USGS Spectral Library Version 7: U.S. Geological Survey Data Series 1035, 61 p., https://doi.org/10.3133/ds1035.