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Interactive comment on "Holocene phototrophic community and anoxia dynamics in meromictic Lake Jaczno (NE Poland) using high-resolution hyperspectral imaging and HPLC data" *by* Stamatina Makri et al.

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Anonymous Referee #2

The paper by Makri et al makes use of a high resolution, laminated lake sediment record from Poland, which covers the last 9500 years. The authors use high-resolution (mm-scale) Hyperspectral Imaging pigment data together with low resolution (dm scale) chlorophyll and caretonoids data to document the impact of humans into the lake and nearby environment. The lake is particularly suited for such a study, because

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pollen evidence document that the region is used by humans only since about 500 years. The region was in a natural state apparently for most of the Holocene. The lithology is presented as three main units, which are visually apparent. The authors have quantified these lithological units by major element geochemistry, which match the visual apparent units. The 14C dating of the core is excellent. About 20% of the record appears to be in addition varve counted. The paper is well written and organized. The figures are clear.

General response: We greatly appreciate the careful revision and the constructive comments provided by the Anonymous Referee #2. We have addressed the concerns each by each below. We give our response right below each comment. We understand and we mostly agree with the concerns of the Reviewer and we trust that our responses and subsequent modifications in a revised manuscript will clarify and sharpen our interpretation and focus of our paper.

Comment 1: My main concern is about the data itself. The presented multiproxy data show all very similar structures, but I have to confess, that I don't see an interpretable pattern in the downcore data or time series, except those features, which are related to the apparent lithological changes. A well visible change of k-myxol at 4500 BP is the only specific change beyond those features that may be explained by the lithological units. The first prerequisite for a convincing interpretation must thus be a full documentation of the lithology. It is given as a side bar to Figs. 2, 3 and 6, but this is hardly readable. I suggest to stretch Fig. 2 on the depth scale and to document all litholological units with fotos of the sediment. This is indeed the crucial information before one can decide, if the interpretations of the many proxy curves are sound.

Response: Climate and catchment evolution changes are the main drivers of pigment variability in Lake Jaczno, as explained in the text. Indeed, these changes are also registered and reflected in the lithology. Thus, they coincide largely with the lithological units, which is very interesting here. It is not always the case that lithological units and pigment or other organic proxies are so consistent. For Figs. 2, 3 and 6 we have en-

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larged the column with the lithological units so they are now better readable and clear. The detailed documentation of all lithological units asked by the reviewer is provided in the supplementary material (Fig. S3). This figure shows all lithological units with photo documentation of sediment structures. In our opinion, this is the appropriate place and avoids an overly long main text. A clear reference of the content and presence of this Figure is found at the beginning of Section 4.3.

Comment 2: The multiproxy time series shows the major changes in the depth interval of the section with many slumps. The slumps should be deleted from the figures on age scale. In addition the source of the lithogenic matter and its sedimentation processes should be inferred before the start of paleoenvironmental interpretations.

Response: Indeed, the slumps were removed prior to the chronological modeling (as explained in the text) but we decide to leave them in the Figure. This information might be helpful for other research groups working in this lake in the future (helps the stratigraphic correlation of cores). The sources of the lithogenic sediments are in the catchment. According to our interpretation model (see text Section 5.2) the lithogenic components are indicative of surface processes in the catchment (erosion).

Comment 3: Another clear signature is a spike of almost all organic components at about 2000 BP and in the year 1996. What happened in 1996? Was it a climatic anomaly? Was there any construction work in the catchment? The authors should make use of this historical information to “calibrate” their signals.

Response: We attribute these peaks to warmer summer temperatures; this is, however, especially for the period around 2000 cal BP, not well established. Nonetheless, 1996 CE was quite unusual in terms of climatic conditions. The winter was very long and the temperatures were low until around April 20th (Czernecki and MiÄŹtus, 2017). Since April 20, temperatures increased very quickly together with very warm airflow from North Africa. Temperatures reached 25-27 °C during the day and even 10-15 °C at night (“IMGW-PIB, Suwałki Meteorological Station,” 2017). Hence, after a long

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winter with thick ice cover, summer stratification developed almost immediately. These climate conditions were very similar to 2013 CE (long and cold winter combined with hot spring and long summer stratification, Fig. 1d). Also 1997 was similar: the winter was long (until April) and then a very warm spring. Increased summer temperature registered after 1990 CE and eutrophication (maximal pigment concentrations) had a positive effect on the persistence of meromixis (Butz et al., 2016). In our interpretation, we place emphasis on the long-term trends (not individual data points) as shown in the Zones I – IV of the RDA (Fig 5); Fig. 5 shows the differences between the pigment zones and their relation with temperature, vegetation cover and surface processes. We have added this information about the warming of the temperature after 1990 CE in the text in Section 5.2.3.

Comment 4: The authors should also present the main pollen records in direct comparison to their two main organic proxies. All interpretations might become much more convincing just by an appropriate visualization.

Response: This is basically shown in our synthesis Fig. 6 displaying AP/NAP, Bphe and TChl. All details of the pollen profile have been published in Kinder et al. (2019) and Marcisz et al. (2020). From other works in lakes from Poland, Greece and Switzerland, we know that it is mostly the AP/NAP pollen ration (or the density of the forest) that influences the mixing regime (i.e. which is the purpose of our paper).

Comment 5: In summary, I don't feel capable of coming to a final evaluation of this manuscript. I suggest the authors add the missing information (lithology with details, fotos of sediments, pollen profiles) and provide convincing explanations for the spikes near 2000 BP and 1996 AD. It would need a new figure with only those 5 or 7 proxies, which allow a convincing synthesis. Such a synthesis figure could show a well readable lithology, two pollen demonstrating the absence of humans, two high resolution HSI and three HPLC records, all well scaled – to indeed document the major changes - and not just many, many similar organic records. If this figures shows a clear pattern, and the signal of 1996 is understood, the study might become an excellent record from

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a beautiful site.

Response: As mentioned above, the information about the lithology (with pictures) is shown in the supplementary material (Fig. S3). Also the most important proxies supporting the arguments (and purpose) of our paper are already shown in our synthesis figure Fig. 6 (pollen, temperature, both hyperspectral indices, the most diagnostic pigments indicating anoxia, and lithogenic flux).

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Please also note the supplement to this comment:

https://bg.copernicus.org/preprints/bg-2020-362/bg-2020-362-AC2-supplement.pdf

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