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Reconstructing past hydrology of eastern Canadian boreal catchments using clastic varved sediments and hydro-climatic modelling: 160 years of fluvial inflows

By Antoine Gagnon-Poiré, Pierre Brigode, Pierre Francus, David Fortin, Patrick Lajeunesse, Hugues Dorion and Annie-Pier Trottier.

Point-by-point reply to the referee #2 comments

The review made by the referee #2 is gratefully acknowledged. The manuscript has been modified in response to the comments. In the following document, the referee comments are listed in italic blue, the specific responses to referee comments given by the authors are in black. The line numbers mentioned in section "reply", refer to the line numbers in the Marked-up manuscript. Suggested minor changes referring to a comment from the previous report are proposed at the end of this document.

REFEREE #2

General comments:

The manuscript by Gagnon-Poiré and co-authors entitled 'Reconstructing past hydrology of eastern Canadian boreal catchments using clastic varved sediments and hydro-climatic modeling: 160 years of fluvial inflows' has been revised according to reviewer' comments and a detailed point-by-point response to reviewer comments is presented. Most comments are adequately considered by the authors, but there are still two points that could be better clarified.

> Reply:
> *We thank reviewer #2 for his positive comments on our revised manuscript.*

Specific comments:

First, I agree to the argument that by pooling more than one sediment record local disturbances of the sediment record might be minimized and I appreciate especially the approach to combine a distal and proximal core for the part of the lake influenced by the Naskaupi (NAS-1 and 2). However, it would have been logical to apply the same approach with a distal and a proximal core also for the Beaver River in order to get both parts of the large catchment similarly represented by sediment records. In this respect, it should be clarified why only one core representing the Beaver is included in the analyses and how this different representation of catchments in sediment records influences the analyses.

Reply:

The main tributary of Grand Lake is the Naskaupi River. Considering that the watershed of the Naskaupi river is twice as large as that of the Beaver River, we estimated that the Beaver River's discharge is at least two times less than the Naskaupi River discharge. The Beaver River delta slopes and associated sediment waves are much less developed than at the mouth of the Naskaupi River, which also shows that the Beaver River is the secondary tributary of Grand Lake. So, we believe that the site BEA-1 alone is sufficient to represent the signal for this Grand Lake's sub-watershed. Our goal during the coring mission carried out in 2017 was to focus on the hydrological signal of the Naskaupi River watershed as the hydrometric station 03PB002 measuring the discharge is present in this specific Grand Lake sub-catchment. The purpose of collecting a core at the mouth of the Beaver River was to sample this smaller adjacent Grand Lake's sub-catchment, which is devoid of anthropogenic modifications.

As mentioned in section 3.1, site BEA-1 and NAS-1 were collected from locations sharing relative similarities (at the distal frontal slope of the Beaver and Naskaupi river deltas; fig. 1c) while site NAS-2 was collected away from the Naskaupi River delta, at the beginning of the deep lake basin. We think that the sites NAS-1 and NAS-2 record the Naskaupi River hydrologic signal, but are also susceptible to record the Beaver River signal too, due to their location in the axis of both rivers. Yet, NAS-2 and NAS-1 can be considered as distal cores from the beaver River as well. It is also to consider that we used the DLT and the P99 for our final reconstructions. Those proxies have been extracted from thin sections for the last 160 years (1856-2016) for cores BEA-1 and NAS-1, and only for the last 47 years (1968-2016) for core NAS-2. Thus, the main coring sites, which are BEA-1 and NAS-1, cover the entire length of the combined series while the NAS-2 site contributed only to the surface of the combined series.

Text have been added (lines 177 to 182) to provide additional information on the location of the coring sites.

Second, the effect of the Naskaupi River diversion on sedimentation in the NAS cores as described in lines 670-687 in the manuscript still is not entirely clear. I understood that sedimentation increased due to more sediments available in the catchment due to the changes caused by constructions. It is also stated that the NAS-1 site became 'more sensitive to maximum discharge variations in spring than mean annual discharges' (lines 675-676). This would make sense, but apparently this applies only for parts of the spring runoff because 'the capacity of early spring discharge to transport fine sediments… decreases along with the decrease in water supplies'. This apparent contradiction and differentiation in 'early spring' and 'spring' should be better explained. Furthermore, the different behavior of site NAS-2, where sediment input declined after 1971 in contrast to NAS-1 where it increased, could be better explained. Is that due to the lower transport capacity of the discharge and does it mean that the additional sediment is mainly accumulated on the delta, thus changing the entire delta geometry?

<u>Reply:</u>

We agree with those comments. We modified the text to better highlight the difference between the fine early spring layers associated to the 'early spring discharge' and the detrital layers mainly related to the 'maximum spring discharge' (lines 694 to 711). We also proposed the potential mechanism for the recent (post-1971) difference in sedimentation between the site NAS-1 and NAS-2 (lines 719 to 725).

We would also like to make some additional minor modifications to better address a comment made reviewer #2 in her/his former report.

''*In general, it is difficult to follow the large number of different statistical correlations between cores, proxies, proxy reconstruction and model results. A more concise approach with a focus on main correlations would make the manuscript easier to read.*'',

While working on this revision, we realized that correlations with climatic variables were seldom described and discussed and were less relevant. Therefore, we propose to focus our study on the relations between hydrological variables (calculated from the time series of daily discharge) with Grand Lake's varved sequences. We suggest to drop the presentations and the discussion about the correlations between the few climatic variables (winter snowfall, spring temperature, and rainfall) with varve parameters. Deletions proposed here are far from being substantial and are based on the removal of only 80 words from the manuscript. The suggested cuts related this suggestion are highlighted in yellow in the marked-up manuscript.

We consider that removing this information does not affect the quality and the interpretation of our dataset, as well as the scientific content of the manuscript. On the contrary, it allows to better focus on the hydrological series contained in the varved record, which makes the manuscript simpler and easier to read as initially suggested by the comments of referee #2. We are aware that these changes could have been proposed previously, and we are open to disregard these modifications if the editor's is not comfortable with them.