

Interactive comment on “Effects of climate, fire and vegetation development on Holocene changes in total organic carbon concentration in three boreal forest lakes in northern Sweden” by P. Rosén and D. Hammarlund

P. Rosén and D. Hammarlund

Received and published: 8 September 2007

Thanks to the referees for valuable comments on our manuscript. We have made most of the changes suggested by the referees. However, we also think that the referees may have misunderstood parts of the manuscript and have clarified these areas in this reply. Line numbers refer to locations in the old, not revised manuscript.

Comment 1. Referee #1 points out that many conclusions are speculative and gives an example from Makkasjön during early Holocene. We agree that the reconstructions from early Holocene are uncertain, as we have already pointed out in the paper. Accordingly, we have also deleted speculations about Makkasjön in early Holocene. In

addition, we have also added some additional references regarding the uncertainties from this time period.

L 224: Often interpretations of sediment records from early Holocene in newly deglaciated terrain can be difficult due to soil forming processes, vegetation development and lack of modern analogues in the calibration set (eg. Rosén et al. 2003; Bigler et al. 2003) and the TOC reconstructions from the early Holocene should therefore be interpreted with caution.

Comment 2. Referee #1 argues that the minimum difference that can be judged as significant are 1.1 for pH, 4.4 mg/L for TOC and 97 mg Pt/L for color. I am uncertain how these values have been calculated, as (on L189-202) we state that the prediction error for the models are 0.4 units for pH, 1.6 mg/L for TOC and 35 mg Pt/L for color.

Comment 3. Referee #1 Since this is only the second paper were NIRS is used for TOC reconstructions we agree that some conclusions are speculative and more lakes needs to be studied to verify the results (work in progress). Therefore we have now clearly stated in the beginning of the Result section that the data presented are not intended to be conclusive but should be seen as a step forward in the development of this method, as, for the first time, NIRS inferred TOC is evaluated against independent proxies from the same sediment core and also compared with literature data. The aim has also been slightly modified to clarify that the results from NIRS are not conclusive. In addition, we state that independent paleoecological and sediment stratigraphic data are used to find support for NIRS as a new method to reconstruct TOC in lake water and to strengthen the reconstructions from NIRS. However, we feel that some of the observed correlations are worth discussing, and have therefore done so.

Comment 4. L46: The word change is already included in the sentence: Important factors that have been suggested include changes in precipitation, pH, nutrient load, fire regime, temperature, photodegradation, and land use.

Comment 5. L47: Allochthonous TOC has been added.

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

Comment 6. L73-77: The meaning with this paragraph is that we cannot trust diatoms as the only proxy for TOC reconstructions, when we know that diatoms are more sensitive to pH and the diatom/TOC (colour) models have fairly poor statistical performance. Therefore there is a need to develop new methods like NIRS to assess past changes in TOC. The infrared spectra incorporated in this study is not strongly related to pH, and thus is more reliable than the diatom data. Furthermore, the correlation between TOC and pH in the 100 lake calibration set for NIRS is $R=0.0$. Therefore we believe that using NIRS we can reconstruct lake water TOC independent on pH. This has been stated more clearly in the discussion.

Comment 7. L82-83: The referee is right that it can be difficult to separate the effect of fire, mire formation, vegetation development and humidity in reliable manner using paleolimnological data since they can be dependent on each other. However if we want to assess long term changes we are dependent on historical archives which gives us more indirect information than if we would make a present day study (eg. before and after a fire). In our project design we have tried to separate these factors by selecting one lake affected by a mire, one with a very small mire and one lake without a mire. Where a large increase in the TOC was observed in the mire lake, independent data on C/N ratio (to assess changes in aquatic versus terrestrial input), diatoms (indicating changes in pH) and previous studies was used to corroborate these observations.

We believe the separation of charcoal fragments into two size classes enables us to distinguish between local fires and regional fires. An increase in only small charcoal fragments may indicate more regional fires and drier climate without a direct effect of fire on the studied lakes. An increase in large charcoal fragments can indicate more local fires but also drier climate. We have already said in the discussion that the effect of local fires and drier climate cannot be separated.

To assess the combined effect of liming, rotenone treatment, introduction of char we have chosen 2 lakes which have been treated and one lake which has been untreated. Since we only can see an effect in the TOC reconstruction in the 2 treated lakes we see

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

that as an indication that the treatment is a driving mechanism behind the changes.

Comment 8. L99: One year after liming has been removed

Comment 9. L171-175: LOI (550°) has been inserted and the sentence should now be clear.

Comment 10. L225: sentence about high pH and primary production has been removed.

Comment 11. Referee #2 point out that the chronology is poor. In the method section we have already said that only trends should be compared between lakes. We have now added information on this in the beginning of the Result/Discussion section as well: ¶When interpreting the data it is important to consider the large uncertainties in the chronology associated with the 14C method and bioturbation. Thus, only trends should be compared between lakes.¶;

However, neither Lundsjön nor Sotaure show any rapid changes throughout the Holocene, precise dating is therefore not as important. We do discuss a sudden change due to liming in Lundsjön and Makkasjön in recent time and this change has been well dated using SCP. The second sudden change we discuss occur only in one lake (Makkasjön) and a precise comparison between lakes is therefore not important for the discussion.

Comment 12. Referee #2 wants us to do all analyses on all three lakes but was not possible due to limitations on time and funding. In our project design we have chosen 3 lakes to be able to address as many questions as possible. All 3 lakes are very close to each other (2 km apart) with similar vegetation. These 3 lakes should therefore have experienced similar climate, humidity and regional fires, which we believe is adequately represented in sediments from Makkasjön. The impact of mire is catchment specific and here we use the lake were all analyses have been performed, Makkasjön, as an example of the response from a mire. 2 lakes has experienced liming and introduction

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

of fish and in one of them we have done all our analysis, the second lake has been used to confirm the TOC trend in recent time due to the same treatment and the third lake is used as a control lake for TOC.

Comment 13. Referee #2 asks us to discuss the role of internal factor such as acidification, alkalization and in lake removal of carbon. This is already done on L 314-323.

Comment 14. Referee #2 wants us to do partial canonical ordinations, however we are unsure of how this would be applied to this study. We could do partial canonical ordinations and compare the spectral data (and not the NIRS inferred TOC which is univariate) with the drivers and thus partial out the effect of pH, charcoal etc to get the percentage of spectral variance that the drivers explains. However, that will not tell us how large proportion the drivers will explain the NIRS inferred TOC. The NIRS inferred TOC model incorporates all wavelengths but with different weightings for each wavelength. Thus determining the influence of the drivers on the spectral data does not actually indicate the relationships between the drivers and TOC. Furthermore, we do not believe it is possible to do partial canonical ordinations to assess the relative contribution of these drivers on the inferred TOC values, as the latter is only one variable. If the referee knows of a method by which this can be achieved, we would welcome the advice.

Comment 15. Referee #2 wants us to do a more detailed description on the environmental settings of the lakes and show independent data on when the mire started to develop in the catchment of Makkasjön. We have added that blue horizontal lines indicate mires in the legend for figure 1. Otherwise we think that the map together with the information on vegetation for the study sites (L89-103) should be enough. We have already used the response from the diatom community composition (indicating more acid conditions due to more humic acids entering the lake from the mire), C/N ratio (indicating more terrestrial input of carbon) as independent proxies for when the mire were formed in Makkasjön.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

Interactive
Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper