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Interactive comment on "Seasonal lake surface water temperature trends reflected by heterocyst glycolipid based molecular thermometers" *by* T. Bauersachs et al.

Anonymous Referee #3

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General comments

The manuscript by Bauersachs et al. deals with the question to what extent the relative distribution of different species of heterocyst glycolipids (HGs, lipids unique to nitrogen fixing cyanobacteria) reflects the water temperature in their habitat. This question is investigated in a shallow lake in Northern Germany by evaluating correlations between several environmental parameters and HG distribution. If a specific link between HG distribution and water temperature can be confirmed, analysis of HGs in lake sediment would enable reconstruction of paleotemperature in lacustrine systems, for which the conventional lipid proxies (e.g. TEX86, UK37) are not suited.

The need for a robust molecular thermometer in paleolimnological studies is convincingly explained by the authors, and the aim to implement such a tool based on HGs is definitely an interesting topic. The authors contribute to this topic with a valuable set of data that confirms a local correlation between HG distribution and water temperature. The information in the manuscript is well structured and presented in a precise way; results are robust, interpretation is convincing and conclusions relevant.

My main concern regarding this manuscript is that the possibility of/need for a global calibration of the HG-based molecular thermometer is not, or only scarcely, discussed. In previous work, Bauersachs et al. (2014) demonstrated that HG distribution in different species grown at the same temperature varies strongly, as does the slope of the correlation between HG distribution (HGI26) and temperature. Will the HG to temperature conversion therefore depend on the single species present in a given lake? Does this make a global calibration impossible? Is a local calibration, as the one performed in this study, always needed to interpret the HG signal in the sediment layers? Is such interpretation even possible if we assume that the cyanobacterial community might change from year to year? In my opinion, these kind of questions need to be addressed.

Specific comments

P. 755, l. 1-5. While it is true that in the two strains studied by Bauersachs et al. (2014) "the relative proportion of HG diols significantly increased... with increasing growth temperature", the authors should also mention the large differences in the response of HG composition to temperature observed in these two species. The abundance of HG diols (or the value of HGI26 and HGI28) at a given temperature, as well as the slope of the correlation between HGI26 (or HGI28) strongly differ between Anabaena CCY9613 and Nostoc CCY9926. At this point the authors could actually introduce the caveats already mentioned in Bauersachs et al. (2014): "additional culture studies will be necessary to determine whether or not individual species of heterocystous cyanobacteria adjust the composition of the heterocyst glycolipid layer differently with growth temper-

BGD
12, C127–C130, 2015

ature, which would complicate the establishment of a universal temperature calibration"

P. 756, l. 2-4: Date on which the sediment was sampled could be given here in order to have a better understanding of which watercolumn signals are possibly being incorporated into the sediment signal.

P. 756, l. 6: "Biomass production" sounds strange to me, as not production, but rather the "standing stock" is evaluated

P. 759, l. 10-13. As it stands, the calculation of biomass ("the weight difference between wet and dry cell material on the preweighed filters", wouldn't that just be the loss of water?) sounds confusing. In addition, to my understanding, organic biomass would rather be obtained after combustion ($\sim$500°C) of the sample and calculated as the difference between combusted and dry weight. Dry weight (organic and inorganic) and wet weight (organic and inorganic) would be obtained by comparison to the preweighed filter.

P. 760, l. 10-19: The authors could shortly address the fact that the studied lake is very shallow, therefore the impact of the watercolumn signal in the surface sediment is immediate. Possibly in deeper systems, a more complex picture could emerge, due to contribution of different communities, degradation during sedimentation etc.

P. 760, l. 23-P. 761, l. 26: This rather long paragraph could, in my opinion, be significantly shortened. The authors describe that the observed HG profile is taxonomically rather unspecific and, based on previous studies, could be attributed to members of the genus Anabaena and/or Aphanizomenon. As taxonomical assessment is not a goal of this study (and HG distribution probably not the proper tool for a gross classification that can be achieved more easily by microscopic observation), I would suggest to present this information in just two or three sentences (e.g. l.17-21.).

P. 766, l. 4: Given the fact that only surface sediments are analyzed (0-1 cm), I don't think that the question if the HG signal "is preserved in the sediment" can be addressed.

BGD
12, C127–C130, 2015

P. 766: Do the authors consider that a larger input of HG28 during late September (and October), when their relative abundance in the watercolumn increases, could be partially responsible for the lower temperatures reconstructed by HDI28 and HTI28?

P. 767, l. 14-18: When addressing that HG in sediments represent summer signals, a short mention to the annual cycle of Nostocales in temperate lakes could be of interest (e.g. Hense and Beckmann, 2006: Towards a model of cyanobacteria life cycleâĂŤeffects of growing and resting stages on bloom formation of N2-fixing species; Mehnert et al., 2013: Population dynamics and akinete formation of an invasive and a native cyanobacterium in temperate lakes or similar)

P767-768: As mentioned in the general comments section, a comment on the need for and feasibility of a global calibration for the HG thermometer would be very welcome.

Supplementary Figure 4a: Please use the same scale (e.g. 6-24°C) for both x and y-axis to allow better comparison

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Interactive comment on Biogeosciences Discuss., 12, 751, 2015.