

Interactive comment on “Lake El’gygytgyn water and sediment balance components overview and its implications for the sedimentary record” by G. Fedorov et al.

Anonymous Referee #1

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General comments

This paper presents results of water and sediment balance investigations at Lake El’gygytgyn, in Central Chukotka. This is presented to provide important information about the hydrologic balance and sediment flux to the lake for interpretation of the 3.6 Ma paleo record extracted from the lake, and for understanding of the sensitivity of basin sedimentology to climate forcing in the past. The information presented here is not completely fitting the scope of Climate of the Past, but may be relevant for publication within the framework of the special issue about Lake El’gygytgyn.

The overall quality of the paper is good, as well as the level of the English language,

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with minor technical issues. However, the way the paper is organized makes it difficult to follow, and it needs to discuss more thoroughly the water balance components and the uncertainty around the data; some of the estimations of different water balance components are rather weak and not supported by statistics. As it is now, much of the manuscript relies upon estimates and assumptions. Some statements or interpretations in the paper would benefit by further explanation, including statistical analysis. Also, many papers in the literature that present and discuss water balances in cold regions with permafrost are not at all related to here (e.g., Zhang et al. 2003, *J Hydrology*; Woo et al. 2008, *Permafrost & Periglacial Processes*). Overall, there are several areas where a more critical stance would strengthen the manuscript further, and some of these are outlined in the Specific Comments section below.

Finally, the authors announce in the introduction that the results are important for interpretation of the long paleorecord and thus provide information on modern seasonal hydrological and sediment conditions of Lake El'gygytgyn, which is interesting from a hydrological and sediment view. However, there is little explanation of and implications for how their findings can help to understand the paleorecord. I suggest making more of these links, as it would strengthen the paper.

Specific comments:

Introduction I am missing a more thorough site description explaining the region e.g., permafrost, vegetation, geology, climate etc.

Line 14-20: Why is mean annual liquid precipitation presented for two different time periods (2001-2009 and 2002-2007)?

Methods 2.1: This section is difficult to follow and should be expanded, e.g., (i) how was the seasonal discharge/runoff estimated from the 1-3 measurements for each measured stream, (ii) what is the uncertainty in using some measurements from snowmelt period versus the end of the summer, (iii) what is the uncertainty in using an average unit area discharge for the unmeasured streams, and (iv) is the time period of outflow

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activity based on the period where measurements were carried out for the Enmyvaam river?

2.2 line 18-20: How was the extrapolation of the summer liquid precipitation carried out?

2.3 Try to be consequent when referring to the groundwater components, and avoid using different terms; e.g., ground component, groundwater supply, underground runoff, underground water supply and underground supply.

Line 1: I suggest writing Groundwater components

2.4 This section needs to be expanded. The regional open water evaporation data is taken from Sokolov (1964), what is this data based on and how accurate is it to use data from 1964 to current conditions in regard to climate change?

2.6 The method for estimating the total seasonal fluvial sediment supply and Enmyvaam River sediment runoff need to be expanded and I suggest including uncertainty analysis.

2.7 Line 14: I suggest writing ... as described in section 2.6 (instead of earlier)

2.8 When estimating the residence time for Lake El'gygytgyn, did you use the seasonal data to estimate water supply volume for one year, and how was the fluctuation of the lake level handled (consider it influence the lake water volume)?

Results and discussion 3.1 When estimating the total water yield by inlet streams and runoff at the Enmyvaam headwaters, what are the uncertainties in these numbers; considering that streamflow has been measured for some selected rivers during both snowmelt period and/or "dry" period, and that the groundwater inflow and outflow is unknown? Please expand the results from the water balance study and include an uncertainty analysis or discuss potential sources of error.

3.3 Contribution of rainfall precipitation was 73 mm during summer 2003. This is on

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the lower range (70-200 mm between 2002 and 2007). Was 2003 a “wet” or a “dry” year and what implications may that have on the water balance study? In addition, what is the uncertainty in estimating liquid precipitation based on extrapolation from one automated weather station?

3.4 This section is difficult to follow, both the structure and the results presented. For example, the results show that annual water input was ca 0.13 km³ and that Ebmyvaam River outflow was only 0.05 km³. There are several water balance component that add up to these numbers that each may have a level of uncertainty. How are these uncertainties dealt with? Also, how was the annual water input estimated, taking into consideration that measurements were carried out at different times only during the summer season (some during snowmelt and some during dry period)? How was the flux from active layer melting estimated? Lake El'gygytgyn is located in the continuous permafrost zone, but there is no discussion regarding permafrost/frozen ground and what implications that may have on the hydrology in the region, e.g., how it may affect the groundwater flow (both inflow and runoff). In addition, please expand discussion about the residence time for the lake, especially as this is of interest for interpreting the paleo record.

Conclusions What implications may current climate change have on these results and how will results from this study be used to better understand the paleo record?

References I am missing references on related water balance studies in cold regions with permafrost.

Other papers in the special issue have cited the following article:

Federov, G., Bolshijanov, D. J., and Schwamborn, G.: Hydro- and sedimentological-balanced research from Lake Elgygytgyn, Chukotka, in: The System of the Laptev Sea and Adjacent Arctic Seas Current Status and History of Development, edited by: Kassens, K., Lisitzin, A. P., Thiede, J., Polykova, Y. I., Timokhov, L. A., and Frolov, I. E., Moscow University Press, Moscow, Russia, 9 pp., 2009.

Is this the same as the present study?

Figure 1: The resolution needs to be higher, and the symbols on the map larger to be visible in the paper

Figure 3: Dates for water level measurements is cropped

Figure 4: I am missing the uncertainty (+/-) around the data, see comments regarding uncertainty analysis

Figure 5: Increase resolution and font size This does not belong to the figure caption: "Rain fall, as measured by a tipping bucket, occurs mainly during the summer months of June, July and August, varying from 70 mm, 73 mm, 173 mm, 106 mm, 200 mm and 134 mm from 2002 to 2007 respectively. The gage apparently malfunctioned in June 2008. Soil moisture and soil temperature follow similar trends each year, except in 2006 when high rainfall left soils saturated at the end of summer. The moisture then froze and drained off the following summer. We believe these dynamics strongly support our conclusions that significant amounts of lake water can be stored in and migrate through these gravels, as described in the text."

Figure 6: Increase resolution and font size This does not belong to the figure caption: "Surface soils thaw between day 150– 155 (end of May), with energy from the sun, snow melt, and rain. Within a week the deeper soils thaw. The surface soils begin drying out quickly once thawed, but a water table persists for several weeks between 20 and 40 cm depth, indicating water storage, likely from snow melt and early rain as the soils at depth were dry at the end of the previous summer. This water drains about the time the outlet river opens up in early July. Variations after this point are caused by rainfall, which do reach the 40 cm level quickly, indicating good hydraulic conductivity. Soils then freeze with little trapped moisture between days 273–280 (early October)." I suggest writing: Rain, soil moisture and soil temperature for summer 2003.

Technical corrections: Page 3979, line 15: change in filling to infilling

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Page 3980, line10: replace an with one

Page 3980, line 12: is the elevation in meter above sea level (masl)?

Page 3987, line 11: I suggest “Main portion of aeolian input in the summer. . .”

Page 3987, line 12: replace associate with associated

Page 3987, line 12: replace then with when

Page 3988, line 26: is water level referred to lake water level or river water level?

Figure caption (fig 5) replace malfunctioned with malfunctioned

Try to be consequent in the paper: Lake water exchange or residence time

E.g., ground component, groundwater supply, underground runoff, underground water supply and underground supply?

Outflow, discharge, runoff is often mixed

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