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Interactive comment on "Physical processes of thermokarst lakes in the continuous permafrost zone of northern Siberia – observations and modeling (Lena River Delta, Siberia)" *by* J. Boike et al.

Anonymous Referee #2

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General comments: In general, the paper seems worth publishing. Lakes are frequent phenomena in arctic landscapes, yet still not many studies have been published on their thermal behaviour, namely for multiannual periods including cold seasons. The purpose of observing them but also designing a model and evaluating it with the observed data is important. It is well pointed out that albeit similar studies are around on lakes in these landscapes, a lack of data is addressed with the present study located in northern Eurasia. However, while the study specifically investigates a small number of lakes in the Lena delta in northern Siberia, I somewhat miss a statement on

how applicable the results are for Siberia in general, or how specific the lakes in this study are. It was not so clear to me why specifically the FLake model was used. This could be motivated actually when hinting to the possibility of implementing/coupling it (in)to regional or global climate models, as in fact these large scale models often still very much simplify lake physics, in contrast to what is stated in the introduction (see specific comments). Is there any conclusion on the usability of the FLake model for such a purpose? I would also recommend some statement on the applicability of the FLake concept of self-similarity for such complex systems, and/or e.g. where reasons might be for the disagreement between model and observations during winter time. An advantage of the study is that the measurements of the lake, e.g. water depth, ice break up, and temperatures, are related to data from the surroundings, as river flooding events and river temperatures; the description of the observed phenomena in the lakes is conducted in context with these supplementary observations.

Specific comments: Abstract: Why the FLake model? Is it necessary to mention here the specific model? - 'Wedderburn number': if mentioned, please shortly explain it. - Introduction: Caution: 'thermal dynamics [of lakes] are often incorporated in RCMs and GCMs' is not fully true, as still the representation of lakes is rather simple in large scale models. - 3.2 Lake morphometry: P6647 L 8-10: if not treated here, why mentioned? - many details on the morphometry, but are these related later to the results? - 3.4 Modelling of lake thermodynamics: - P 6649, L 13-15: Golosov and Kirilin and Mironov et al. applied this concept to observations? Not clear to me whether this was also modelling or observations. - 4.4 Summer: - interesting points with the Wd number: 'monthly bottom Ts for some lakes were also warmer than the corresponding monthly air Ts' reasoning given is that radiative heating as well as mixing is at work. - 4.5 Lake heat content: - P 6655, L 11: annually, the energy fluxes should be more or less balanced - I had problems with approaching the energy balance by summing up all terms into an 'annual heat budget [...] up to 1 GJ/mˆ2', in other words neglecting the sign of a term. Latent heat of fusion, e.g., is consumed in spring/summer, yet released in fall and winter. Is the interesting point in that as to how strong the consumption of

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incoming energy through these lakes is (the sales, so to say)? 4.6.3 Thermal properties of the lake sediments and water-sediment heat flux: - really interesting: how much warmer these lakes are than both the underlying ground and the atmosphere. 5. Discussion: - P 6660, L 9: where does this specific number come from, and for which region/landscape? - Is it possible to state that the effect of lakes on PF below is still somewhat unclear, that is, whether a talik necessarily thaws the PF below? - P 6660, L 15-21: If a still downward directed heat flux at the lake bottom during winter really implies PF degradation/warming can only be stated if heat fluxes during warm periods are also mainly downwards. Couldn't it be that lakes, through their much larger heat capacity as they freeze and melt, exert a larger phase lag on temperature variations of the ground as the surroundings? - P 6661, L 6-8: Is it really the case that heat transfer to the atmosphere is of minor importance during winter? Ice has a large thermal conductivity, and the temperature gradient between ice (/water below) and atmosphere is large. Are there any references for that?

Technical - P 6646, L 3: 'were reinstalled' - P 6647, L 8: 'obtained for additional ...' - generally, visibility in Fig.s 4b, 5b, 8c may be be improved - P 6652, L 21: replace 'with a light extinction of ...' with 'assuming light extinction to be ...' - P 6652, L 23: 'radiative' instead of 'radiation' - P 6658, L 2: 'release of heat' - P 6659, L 10-11: 'ice cover thickness' - P 6661, L 11: ' ...such as thawing.'

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