Reviewer #3

We thank the referee for the comments and suggestions.
In the following we reply to reviewers comments/suggestions step by step:

Note: Page/line numbers in reviewer's comments refer to the original manuscript. Our references to page numbers refer also to the original manuscript. In the revised manuscript page number may differs.

1. "The authors calculated a discharge of 0.01 cm/d for Lake A. This is actually zero, especially considering all the uncertainties involved. Thus, the discussion of its significance relative to the total discharge is unnecessary and not relevant."

Response: We agree that such a low discharge is virtually zero and we have toned down this section (page 5004). The overall aim of this study was to estimate the proportion of groundwater inflow to the overall water budget of different lakes. We thus feel that even very low groundwater discharge rates are still noteworthy to report. Our results will allow future investigation to assess the long-term variability of groundwater contributions, including the impact of climate change. These results are also particularly important to assess potential development impacts from in situ oil sands development in the region where significant groundwater abstraction and disposal are proposed.

2. "Surface Flow. The authors conclude that even in Lake B, 86% of the water input to the lake is by surface flow. On the other hand, in their mass balances they have a (hidden) assumption that this surface flow carries no Rn. This had to be studied or at least discussed, especially since the authors mention (P. 4997) that the drainage pattern is poorly developed. A surface flow with no developed creeks could lead to larger rock/water ratios, thus to higher Rn activities. Actually, considering the relatively low Rn activities in the lake, surface flow could account for a major part of Lake B inventory and probably all Rn in Lake A. The nature of this flow should also be discussed. Please note"

Response: We concur that surface water is not always Rn-free. Especially in areas where the water is in contact with uncovered rocks and sediments or when rivers and creeks are influenced by groundwater input. In these cases water flow can potentially deliver a major amount of radon to a surface water body.

In our case, however, the scenario is somewhat distinct due to the ubiquitous presence of thick peat deposits. Riparian peat, up to several metres thick, is present in both watersheds and surrounding both lakes, and all surface water moves across this peat. The water, even if it is in contact with shallow groundwater, is not in direct contact with radon producing rocks or sediments. Surface runoff typically cascades from pool to pool down the peat surface during snowmelt and high runoff events, and often contains a high proportion of pre-event water. For these reasons we assume that surface water discharging into the lakes is radon free. We added the information above on page 5005 to clarify this issue.

3. Lake B. It is assumed (P. 5002) that the 5% of the lake floor is sandy, while 95% is silty. It is not clear what is the basis for this assumption. What observations is it based on?

Response: We added a note in the text to respond this comment (page 5002):

"*This assumption is based on field observations during summer field work. Sediment samples were collected from several locations allowing us to map the areas of sand and silt material*".

4. The percentage of groundwater/total input. The authors claim (P. 5004) that in 2007, groundwater discharge could be up to 64% of the input. However, they base it on their 2008 Rn measurements and on the total low input of 2007. 2007 balances should be based on this year's measurements.

Response: We agree that this would be more accurate to compare our observations with balances from the same year. However, unfortunately, this is not possible in our case, because radon mass balances are not available for the time when water balances are available (the period from 2002 – 2007). We feel that under the assumption of a nearly constant annual groundwater discharge into the lakes, relating groundwater inflow rates from 2008 with surface water inputs of the previous years still illustrates the general magnitude of the process we are studying.

5. The difference between Lake A and Lake B. The authors suggest that the difference in discharge (in favor of B) is related to the higher catchment/lake surface ratio in Lake A, which leads to higher fraction of surface flow. This is true, but it should not affect the absolute value of groundwater discharge, which is actually zero in Lake A. The other explanation of difference in hydraulic properties of the lake floor sounds more reasonable.

Response: We concur with the reviewer that a higher catchment/lake surface area ratio leads to a higher amount of surface water inflow. And we also agree that the absolute value of groundwater is not influenced by this process. So we feel that even the total groundwater discharge into Lake A is close to zero the difference in the catchment/lake surface area ratio between both lakes is an important factor for the observed variation in surface water/groundwater ratio. However, as already mentioned above we have toned down the section of the relevance of groundwater discharge into Lake A (section 3.3) and we also added a recommendation that this specific topic should be part of future investigations (section 4).

6. Discussion. As is, the discussion is poor. In order for the paper to be appropriate for publication in this journal, the authors should include a broader and a more scientific discussion of their results. Mainly, they should discuss it in comparison with other studies of groundwater discharge into lake, even if those were not carried out by radioactive tracers. They should talk about rates (specific discharge), as well as about the water balance significance. They should discuss discharge into the various types of lakes, e.g. tectonic vs. glacial; high vs. low surface/depth ratio; temperate vs. semi arid lakes, etc.).

Response: We agree that discussion may be improved by adding some comparisons to other systems. In addition to the changes already described in the responses to reviewer's 1 and 2, we added the following at the end of section 3.3 (page 5005):

Previous studies of groundwater exchange in boreal plains ecosystems of Alberta have focused primarily on upland dominated watersheds (Ferone and Devito 2004, Smerdon et al. 2005). The results presented here are the first reported estimates of groundwater contributions for wetland dominated watersheds which dominate northeastern Alberta in the vicinity of oil sands developments near Fort McMurray. Although both catchment types are situated within the Boreal plains region, their water budget characteristics as well as their chemical (e.g. pH, conductivity, HCO_3^-)

and physical properties (e.g. water residence time, catchment area) are known to be fundamentally different (Prepas et al. 2005).
Upland dominated watersheds are characterized by lower precipitation/evaporation rates, by drier soils and forested hillslopes which results in different surface water flow potential (Devito et al. 2005). These parameters influence the general composition of the lake water budget. Lakes in upland dominated watersheds are dominated by groundwater inputs, whereas surface water runoff is just of insignificant relevance (Ferone and Devito 200, Smerdon et al. 2005).

We highlight that this manuscript has been submitted to a special issue of HESS: "Cold region hydrology: improved processes, parameterization and prediction". We have thus opted for focusing our discussion on boreal lakes rather than broaden it to include a general discussion of "discharge into the various types of lakes".

7. English. The language is pretty much appropriate. Just one comment: I would refrain from using the term 'radon activity concentration'. Simply use 'radon activity'.

Response: Correction made. We are now using radon concentration (see also Response to H. Dulaiova).

Literature:

Devito, K. J., Creed, I. F. and Fraser, C. J. D.: Controls on runoff from partially harvested aspen-forested headwater catchment, Boreal Plain, Canada, Hydrol. Process., 19, 3-25, 2005.

Ferone, J. M. and Devito, K. J.: Shallow groundwater-surface water interactions in pond-peatland complexes along a Boreal Plains topographic gradient, J. Hydrol., 292, 75-95, 2004.

Smerdon, B.D., Devito, K.J. and Mendoza, C.A.: Interaction of groundwater and shallow lakes on outwash sediments in the sub-humid Boreal Plains of Canada, J. Hydrol., 314, 246-262, 2005.

Prepas, E.E., Planas, D., Gibson, J.J., Vitt, D.H., Prowse, T.D., Dinsmore, W.P., Halsey, L.A., McEachern, P.M., Paquet, S., Scrimgeour, G.J., Tonn, W.M., Paszkowski, C.A., and Wolfstein, K.: Landscape variables influencing nutrients and phytoplankton communities in Boreal Plain lakes of northern Alberta: a comparison of wetland- and upland-dominated catchments, Can. J. Fish. Aquat. Sci., 58, 1286-1299, 2001.