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Discussions

Interactive comment on "Quantifying groundwater dependence of a sub-polar lake cluster in Finland using an isotope mass balance approach" *by* E. Isokangas et al.

Anonymous Referee #2

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Quantifying groundwater dependence of a sub-polar lake cluster in Finland using an isotope mass balance approach

Major comments The study uses stable isotopes of water and some meteorological data to estimate Groundwater dependence of clusters of 67 Lakes. Isotopes of water are proven tool in estimating water budgets of lakes. In this specific case the authors relate the isotope- derived groundwater dependence of lakes to meaningful management problem- the water quality. This is a novel approach. The derivation of normalized humidity using an index lake method is an interesting approach to derive this most difficult parameter. Both the isotope and meteorological data sets are good additions to

the documentation of hydrology the polar lakes. Of particular interest is the thermal imaging meant to derive the lake surface temperature. The uncertainty analysis given towards the end of the manuscript is extremely important given the uncertainty associated with estimation of some of the parameters as well as the sensitivity of the water budget (G index, E/I) and MTT to slight changes in these parameters. By the novelty of the approach, the quality of data and the depth of analyses made, the manuscript merits to be published in HESS. Nevertheless the following specific comments and questions need clarification or elaboration as it fit. Specific comments Section 3.3. Evaporation estimation 1. The authors should indicate the time step used in the evaporation estimation using the mass transfer approach (hourly? daily? monthly?) and as to why this approach is chosen (eg availability of hourly data?). Normally, mass transfer approach works very well for instantaneous evaporation estimation where the dependence of vapor pressure gradient (es-ea) and wind speed in equation 1 is assumed to be nonexistent or at least low. Over long time integrated data the two parameters are interdependent and may not give good evaporation result (as in Dingman, 1994). 2. What is the relation between the empirical constant n in equation 2 (which follows a power law) and the turbulent parameter 'n' implied in the Ck estimation-equation 3. Ck in the Isotope equation in this work is based on n = 0.5. For this reason the equation used in estimation of Ck needs to be elaborated (incorporating the turbulent parameter n) later in section 4.4- line 18 in addition to referring to Gonfiantini, 1986. The Ck (for d18O) values used in this work would be convincing if d2H has been used for the water budget computations using the Ck 2H proposed by Gonfiantini, 1986 and get comparable water budget estimation. Section 4.2. Local isotopic composition 1. Please replace 'intersect' by 'intercept' in section 4.2 line 11 2. Line 16âĂŤ what is the source of 'evaporation signal' and how is linked to the enrichment discussed in line 21. One major issue here is what is the role of these enriched groundwaters in feeding next downstream lakes? If this enriched groundwater enters into the next downstream lake it has a bearing on the interpretation of the I/E ratio of the next lake as this affects the δIT of the next lake downstream. To avoid this confusion the authors need to briefly provide groundwater table map (if available) or at least the geographic occupation of the different lakes and discuss if such lake interconnection exists via groundwater. Section 4.4. Quantifying groundwater dependence of the studied lakes 1. A brief discussion about hydrology of the terminal lake Kissalmpi (pond/lake) is needed so as to convince readers this lake can be used as an index terminal lake. The lake has been chosen as a terminal lake based on the assumption that it shows the highest enrichment. To substantiate this the authors need to give information about a) if the geology underneath the lake bottom allows this assumption –eg presence of clay deposits, b) if the lake occupy the lowest place in the region where all waters converge but little chance for leakage and c) compare the isotopic composition of the lake with respect to the hypothetical 'limiting isotopic composition- δ* (Gonfiantini, 1986)' for the region and d) this is not a changing volume/shrinking lake during that time of the year. 2. In section 4.4 line 26 reads "The lowest G value (27.8%) was obtained for Kissalampi pond, which is comparable to a terminal lake." This argument appears incorrect. The G reflect the inflow index not the outflow which governs whether a lake is terminal or not. This needs correction. 3. Figure 8 and 9 add little value in the manuscript. If the authors claim this could add more value, elaboration is needed. Section 5. Conclusion One or two lines of argument stating the presence or absence of any pattern in groundwater dependence by geographic position (upland, midland, center etc) may be interesting. Other comments Figure 3 . In the line marks please use multiple of 5 in the vertical axis Abstract- Line 3: please add 'and quantity' after 'role' In evaporation estimation, section 3.3, the authors used temperature of the surface part of the lake water body to estimate the saturated vapor pressure es (normalization has been applied to temperature of surface part of lake water body). In isotope section the humidity has been normalized to temperature of evaporating surface. The two (mass transfer and evaporative isotope fractionation) are based on similar theory and one temperature value should be used in both cases, in principle.

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