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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Spatiotemporal variability of oxygen isotope compositions in three contrasting glacier river catchments in Greenland" *by* J. C. Yde et al.

Anonymous Referee #1

Received and published: 24 June 2015

General comments:

Yde et al. describe δ18O composition for three river catchments in Greenland, characterized by differing environmental settings, and ranging in size from 13.6 to 9743 km3. These catchments include Watson River in western Greenland which drains a section of the ice sheet, Mittivakkat Gletscher River in southeast Greenland which drains a glacier on Ammassalik Island, and Kuannersuit Glacier River in west Greenland which drains an outlet glacier of the Sermersuaq Ice Cap on Qeqertarsuaq (Disko) Island. The δ18O compositions of each catchment are found to vary widely, and are proposed to be influenced by a range of factors, including subglacial hydrology, climate and the

age of melting ice.

I found it very difficult to draw any important conclusions from this study. In the introduction you elude to the importance of identifying water sources and dynamics at catchment scale to better understand sea level contribution, future hydrological changes and water management issues, but you don't go on to explain how your results make a solid contribution to this. The three catchments you have studied are so different in their physical settings and processes that all you can really say is that very different catchments in Greenland have very different δ18O signatures. A more interesting study might have been how the oxygen isotope characteristics of three catchments of land-terminating sectors of the Greenland Ice Sheet compare; instead, the three catchments in question were chosen because they have been previously studied by the authors, as described in numerous papers.

In the context of the current structure of the manuscript and discussion of the data, the material presented is not enough to warrant a standalone paper, and would perhaps be better suited as supporting data within broader individual studies of the hydrology of these three catchments. With a more considered approach to how the manuscript is structured and in relating the three data sets to one another, a better paper could be produced; as it stands, it reads like three unrelated mini studies.

Specific comments:

In the introduction (page 5846, lines 16-18) you say "Then, we compare our findings with previous investigations to characterize the oxygen isotope composition in Greenlandic glacier rivers.", but in section 4.4 you compare against very few Greenland-specific studies, and also make comparisons with various valley and outlet glaciers in other regions. I would argue that you do not then characterize the oxygen isotope composition in Greenlandic glacier rivers.

The manuscript lacks a proper methods section, within which the sampling strategy for each glacier should have been described. Instead this is included in the combined re-

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sults and discussion section, which is very busy. I'd recommend revising the structure of the manuscript to a standard methods-results-discussion structure, where a separate discussion section which might then describe the key differences between your three sites, and comparisons with other glacier catchments.

The manuscript would benefit from also including a) a description of your hydrograph separation technique, b) a better discussion of uncertainty with regards to instrumental precision, sampling, and the spatial and temporal variations in the new and old water components, and c) an expanded description of runoff measurement in each catchment.

In section 4.1 you state that "The Mittivakkat Gletscher River catchment makes an ideal site for investigating temporal variations in the oxygen isotope composition of glacial river water due to the potential for linking these investigations to other ongoing studies. For instance, information on δ18O is valuable for validating the proportional contributions of snowmelt and ice melt in dynamic glacier models, which aim to elucidate future climate-driven changes in glacier volume and runoff generation." (line 24, page 5850 – line 3, page 5851). Can you highlight which ongoing studies you are referring to?

On page 5852 (lines 18-21) you talk about an assumed channelized subglacial network. Do you have further evidence for channelization? If so, state what it is. It would also be interesting to hear if there is additional evidence for the roof collapse you mention on pages 5853 and 5854. "This suggests that the functioning drainage network transports meltwater from the upper part of the glacier with limited connection to the drainage network on the lower part. Meanwhile, ice melt is stored in a dammed section of the subglacial network located in the lower part of the glacier, and suddenly released when the dam breaks at 13:00 LT on 12 August (Fig. 5)." (5854, lines 4-8). This description is not entirely convincing. Is there more evidence to support this?

Page 5857, lines 27-21: It would be better to show the solutes and suspended sediment time series in figure 8 rather than have to look them up elsewhere, and to state clearly

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why they correlate with runoff but not δ18O.

Page 5858, lines 25-28: Are there any recommendations you can make to help tackle this issue?

Page 5860, lines 15-26: There are a lot of assumptions made here. How much error would you attribute to these assumptions given the temporal variability in δ18O?

Section 4.4 is really more a loose comparison of the three study sites than a discussion of δ18O variability in (Greenlandic) rivers. As suggested above, I would prefer to see this section rebranded as a discussion, with sub-sections on comparing the three catchments, comparison with other catchments, and possibly a section on sources of error and recommendations for future sampling.

Page 5862, lines 14-21: I don't see the value in this comparison given the entirely different environmental conditions.

You make concluding remarks (also in the abstract) about how there are large differences in δ18O composition between Greenlandic ice sheet water, ice cap water, and glacier water. In reality, the sample of Greenlandic rivers studies from which you have drawn these conclusions is very limited, and comparison between the surging Kuannersuit Glacier and Killersuaq Glacier is particularly tenuous. I'd perhaps be careful in concluding that large ice caps have a distinctly different δ18O signature than either the ice sheet or local glaciers, given that you have a sample of two.

Table 7: Within the "Greenland" section it might not be obvious to someone who doesn't study Greenland glaciology which sites are on the ice sheet proper and which drain from ice caps or local glaciers. I'd recommend that you make this distinction within the table in order to better illustrate the differences in δ18O composition between glaciers, ice caps and the ice sheet.

Technical corrections:

Page 5846, line 12: Is 20 years ago recent?

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Page 5846, line 25: I think ‘emanates’ would be better replaced with something like ‘flows’.

Pages 5846, line 26 - Page 5847, line 2: This sentence makes it sound like the sampling site defines the hydrological catchment. It would be better to start a new sentence with “The hydrological catchment has an area of. . .”.

Page 5847, line 14: Does ‘type location’ mean ‘representative location’?

Page 5848, line 1: Again, the use of ‘emanates’ sounds strange here. Perhaps change to ‘originates’.

Page 5848, line 10: MAAT needs to be defined.

Page 5848, line 15: Should read “. . . estimated the catchment area to be. . .”

Page 5848, lines 18-20: Perhaps it would be better to say “. . . comprises two of the most well-examined. . .”?

Page 5848, line 26: There is an ‘a’ missing from ‘downstream’.

Page 5850, line 1: ‘water’ is missing an ‘a’.

Page 5852, lines 27-29: “. . .the runoff suddenly remained constant. . .”. This doesn’t make sense as it’s currently written. Change to something like “the diurnal trend in runoff was interrupted, remaining at a constant level until. . .”

Page 5853, line 4: change to “. . . before returning to a diurnal oscillation of runoff”.

Page 5853, lines 20-21: It might be more appropriate to say “. . . subglacial drainage likely occurs within a channelized network. . .”.

Page 5853, lines 25-26: again, perhaps change to “. . . the possible existence of an inefficient. . .”.

Page 5854, line 3: “. . .is derived from a. . .”.

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Page 5854, lines 19-21: Consider changing the wording to “As a consequence of the surge event, the glacier front advanced from c. 500 m a.s.l. down to 100 m a.s.l. . . .”.

Page 5855, line 13: “related to”.

Page 5855, lines 24-29: This sentence is too long. Consider splitting into one sentence describing the presence of naled and another describing what it is.

Page 5856, line 1: “an outlier”.

Page 5856, line 22: ‘possibly’ rather than ‘probably’?

Page 5857, line 7: “transforms”.

Page 5857, lines 10-13: Consider rewording to something like “. . .frequent loud noises interpreted as drainage system roof collapses were observed, in addition to flushing out of ice blocks from a marginal hydrological portal, suggesting ongoing changes to the internal drainage system.”

Page 5857, line 16: Perhaps change “are seen as” to “appear as”

Page 5857, lines 23-24: This sounds like sampling was done in May, June and July in 2005, 2007, 2008 and 2009. Rephrase to something like “sampling was conducted during the melt season in 2005. . .”.

Page 5857, line 24 – Page 5858, line 5: The information in these lines is confusing. Rephrase to better pull out the point(s) you’re trying to make here.

Page 5859, line 14: “. . .captured due to the sampling period”.

Page 5861, line 27 – page 5862, line 2: Needs to be rephrased. I suggest something like “In the quiescent phase following the 1995-1998 surge of Kuannersuit Glacier no diurnal oscillations in δ18O were observed. However, the most recent result from 2005 indicate. . .”.

Page 5852, line 12: “. . .large glaciers with lateral tributaries.”.

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Page 5852, line 14: Perhaps say something like “ice cap outlet glaciers” since Leverett or Russell could be described as large outlet glaciers.

Page 5864, line 7: “At the seasonal scale. . .”

Page 5864, line 8: Remove ‘subsequently’.

Page 5864, line 17: “This is in contrast to. . .”.

Figure 2: I can’t see any details or read the text on these three images; the layout of this figure should be changed to optimize page space and image size.

Figure 3: The x-axis labels on these two charts should be edited to better describe the independent variable, i.e. “Date”.

Figure 4: As for figure 3.

Figure 5: As for figure 3.

Figure 7: The x-axis has no label here.

Figure 8: As for figure 3.

Figure 9: All of the text on this figure is too small.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 5841, 2015.