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The Cryosphere Discussions

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Interactive Comment

Interactive comment on "Evidence of meltwater retention within the Greenland ice sheet" *by* A. K. Rennermalm et al.

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Rennermalm et al. (2012) provide a detailed comparison of the timing and magnitude of stream discharge and ice sheet meltwater generation over three years for a small area near the margin of the Greenland Ice Sheet. The authors provide a valuable examination of the timing of post melt season discharge events and of the onset of spring melt and discharge. Rennermalm et al. (2012) make a strong case demonstrating the ease with which the hydrologic system is reactivated. This in turn has important implications for the future if melt seasons are longer and/or more intense. The second primary purpose is to compare total meltwater generation and freshwater discharge with the difference being glacial storage. In this section there is considerable work to be done. The high values of meltwater retained for 2010 and 2011 do not seem realistic given previous work on the adjacent Kangerlussuaq catchment. Regardless more attention is needed to explain where the water could be stored, the specific energy characteristics of the watershed, and the overall water balance component magnitudes.

3371-15: Cite Brown et al (2011) meltwater retention amounts unique data set comparison.

3373-27: Indicate the elevation of ELA close to 1500 m (van de Wal, et al, 2012).

3374-23: Van den Broeke et al, (2011) observe that S5 is situated on the protruding tongue of Russell Glacier, and is influenced by the thermal characteristics of the surrounding ice-free tundra. The resultant enhanced turbulent heat exchange results in significant positive values for SHF and LHF. How has this energy enhancement been accommodated for since your study area is not on a protruding tongue? Is the katabatic wind different than on the tongue of Russell Glacier for the study area?

3375-2: Given that the study area falls well below the local ELA of 1500 m any percolation and refreezing would be temporary. Does the model distinguish the fact that refrozen meltwater in the seasonal snowpack is being melted for the second time, raising melt volume versus runoff volume? The Gruell and Konzelmann (1994) model has meltwater runoff instantly when it reaches an ice surface. In the thin spring snowpack does meltwater in the model have to time to refreeze before reaching the ice surface? If so how much is refrozen? Van den Broeke et al (2008) indicate that at S6 23% of the total melt energy is consumed in snow melt and 40% refreezes in the snowpack temporarily. They further observe that refreezing is insignificant in the lower ablation zone, which S5 is considered to be in. What are the respective study area values? How is the remelting accounted for?

3375-5: Why is S6 used since it is above the height of the study area and not SHR which at 710 m is well within the study area elevation range? I understand SHR is a shorter duration site, but are the records for the study period just not continuous enough?

3376-19: Wrong seasonal wording in sentence.

3376-21: van de As et al (2012) note that in 2010 the runoff was more than twice as large for the Kangerlussuaq catchment than in 2009. This area has a much higher elevation range and the high elevation melt in 2010 could be the answer to this difference from the study area here. It is important to include the actual melt volumes derived from each of the three seasons and the contrast to the Kangerlussuaq catchment is worth noting. van de Wal, et al, (2012) provide annual balance gradients for the K-Transect, how do the model results for your watershed compare?

3379-7: Overall the authors do not provide a convincing argument that the quite high values of retained meltwater found by the model are real and where they might be retained. Sundal et al (2009) indicate that in this region lake supraglacial lake area and volume rises from near zero in early and falls to zero again by day early September. This is not a mechanism for retention in the watershed here. The watershed has a maximum elevation of 860 meters, well below the snowline of 1500 meters in the region. Retention of meltwater within snow or firnpack is not a potential mechanism beyond the short term spring storage, since the snow-firnpack is typically lost even at S6 by the end of June. The authors make an excellent case for the ease of the reactivation of the CHS which argues against subglacial storage, when a drainage network is easily activated by increased water input. Hence, only englacial storage remains as a possibility. McGrath et al (2011) offer crevasse drainage as the best means for the lower ablation zone. How much can reasonably be stored via this mechanism? More problematic for the large values of retained meltwater are the findings from van de As (2012) on the adjacent Kangerlussuaq catchment. They found a good agreement between the calculated meltwater runoff and measured freshwater discharge in 2009 and 2010 both in timing and magnitude. Further they noted that total discharge was 8 and 19% lower than the calculated meltwater runoff similar to the 2009 measurements here. Something seems out of place with 2010 and 2011 greater ablation usually would better activate the drainage system not enhance englacial storage.

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