

## ***Interactive comment on* “Contrasting trends in hydrologic extremes for two sub-arctic catchments in northern Sweden – does glacier melt matter?” by H. E. Dahlke et al.**

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Received and published: 13 March 2012

This manuscript (MS) presents trend analyses of meteorological and hydrological time series of two sub-arctic catchments having differing properties. Although temperature and precipitation display comparable trends in the overlap period (1985-2009), discharge from the glacierized catchment develops differently from that of the (nearly) non-glacierized one. The trends are further analysed in context of climatic indices such as AMO etc and glacier mass balance. The presented longterm records are valuable and the findings are interesting and emphasize the importance of taking glacier-coverage into account in land-surface/ hydrological modeling.

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However, I have discovered a number of weaknesses in the presentation of the material and the discussion of the results. In my view, most of the presented conclusions cannot be drawn based on the discussed material. Nevertheless the job to repair the discussion is manageable and, in my view the MS may become publishable subject to major revisions.

#### Criticism:

1) relationship glacier mass balance - discharge I do agree that glacier mass loss is driving the discharge trends in the glacierized catchment, however, I do have problems with the presentation of the material in the MS and the related argumentation. The authors relate the increase of summer discharge to an increasing contribution of glacier melt (p1059), however, the statistical analysis (Table S1) does not reveal significant correlation between glacier mass balance components and summer discharge. This is contrary to the statement (p1059 L8-10) that  $Q\_JJA$  "had a significant negative correlation with"  $b\_w$ . The value of -0.31 is not suggesting a strong statistical relationship between winter balance and summer discharge and it is not marked as significant in the table (Table S1). Actually, I was surprised that the statistical relationship between net or summer mass balance and summer discharge is not stronger since release of water from a longterm storage (as indicated by negative net balance) should directly enhance  $Q\_JJA$ . This indicates that these relationships are more complex. Therefore it would be helpful to discuss the physical view of such statistical relationships: what are the mechanisms/ processes thought to explain the correlation? Throughout the entire MS, the authors do not discuss this point. However, for instance explaining a relationship between winter balance and summer discharge is not straightforward. One expects that the melt contribution from the glacier is expressed by its summer balance (dominated by ablation), rather than the winter balance which is dominated by accumulation). There may be a line of arguments explaining the observed correlation between  $bw$  and  $Q\_JJA$  (high  $bw \rightarrow$  lots of snow  $\rightarrow$  later snow cover depletion  $\rightarrow$  less melt water production during summer (albedo effect)) but as mentioned such explanation

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is never provided. Also the observation that flood peaks coincide with precipitation events rather than temperature maxima is difficult to explain in absence of a significant precipitation trend, and I do not agree that warming "cannot explain the observed trends in magnitude and timing of floods" (p1059L23). Actually warming and associated glacier retreat may explain flood intensification considering the following feed-back mechanism: negative mass balance → reduction of firn area → reduction of retention capacity → faster response, (see also e.g. Hock et al, 2005). Further, the authors need to account for that the presented glacier mass balance values represent specific quantities (per unit area) but discharge is expressed as a volume flux (m<sup>3</sup>/s). For a glacier of constant surface area, the specific balance relates linearly to a volume of water, but this is not the case for a shrinking glacier (retreat of Storglaciären mentioned on p1059 L15)! This must be addressed, a specific mass balance does not indicate the volume of water released from the glacier without stating the associated surface area! There is lots of current literature discussing reference vs conventional glacier mass balance. Furthermore, material crucial to the discussion need to be presented in the MS, not in a supplement.

2) title Reformulate the title, it raises wrong expectations because a) the MS does not analyse hydrological extremes, but just one of them (flood) and has almost equal focus on summer mean discharge (throughout the entire MS, not only title) b) in my view "does glacier melt matter" is questioning the obvious. If the title is keeps this question, one would at least expect a discussion of possible other explanations for the different behaviour (differences in scale, climate conditions, topography and spatial distribution of meteorological variables, etc). For instance one may discuss whether Tarfala (1000-2100 m asl) has an increasing efficiency in capturing orographic precipitation than Abisko (300-1800 m asl), however, such a discussion is completely missing. This means the question raised in the title is not really addressed.

3) data periods Most focus should be on the overlap period for which meteorological and hydrological data exist for both sites (1985-2009). The presentation of longterm

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trends for individual variables that do not have correspondance with other records is confusing. It may be useful to discuss the overlap period in context of the longterm evolution. However, since longterm trends are only available for some variables/ sites, the MS should focus on the overlap period and use the longterm trends only as discussion material. The common presentation of trends over different subperiods and for different variables is confusing.

Minor points:

Generally, the English should get some polishing, there are many instances of incorrect usage of language: "data area available FROM SMHI" (not "through")... "associated with HIGH temperature periods" (not warm)...I do not list all. Also, adding synonyms or oral language in parentheses makes the language less precise, please stick to a unique terminology.

Consistent terminology: use either Abisko-catchment or Abaiskojokk-catchment (same for Tarfala and Tarfalajokk).

First sentence of the abstract: "it is not clear..." the uncertainty is never specified: what is unclear?

use "glacierized" (referring to present glacier coverage) instead of "glaciated" (past glacier coverage) throughout the MS

P1042 L17 (and several instances in the MS): ..."lacked significant trends...", replce with "...do not show..."

P1042 L21-23: "hydrologic trends indicated an amplification of the hydrologic response..." this sentence is vague, response in terms of what?

P1047L20 the doubtful prophecy by Falkemmark 1972 has been pointed out by another reviewer and needs to be clarified

P1047L1 vs P1048L2: Gauge vs gage, please use consistent terminology throughout

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the MS

P1049L21 "julian day" = interval of time in days and fractions of a day since January 1, 4713 BC, is not the same as day-of-year (which is used here).

P1052L16, increase of precipitation during winter: Førland and Hanssen-Bauer (2000) discuss apparent precipitation increases due to increase of winter temperatures and the associated change in rain-snowfall partitioning. Station undercatch for snow is usually much larger than that for rainfall.

P1053 L14&15: "minimum flood" seems an odd expression.

P1054 L14: "trend analysis on the moving window results" ...is awk wording, better: "...of the smoothed record"

P1055 1st par: stick to either "return period" or "probability" to characterize flood characteristics

P1055 L6: "Climatological controls..." replace by " "Climatic controls..." (the climate exerts some control on floods but not the science of climate)

P1056 L25&26: "...one should expect larger floods...when both SCAN and EA are in negative phase" why is that? Can you discuss the process chain leading to such a relationship?

P 1057 L2&3:"significant negative correlation" between DOY and EA in MAM...a correlation of -0.38 is not very impressive. It seems a bit farfetched to draw conclusions about causal relationships based on weak correlation. I suggest to cut down the entire paragraph to just showing the Table and discuss only the significant relations.

P1058 L20 "...Tarfalajokk do not show significant, increasing or decreasing trends"

P1059 L56: "floods are traditionally snowmelt-generated"...I think they do not care about traditions, but I agree that they are "usually/typically" generated from snowmelt

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P1060 L13-15: "showed significant correlations to NAO and AMO...(Table 7)", Table 7 does NOT show significant correlations between the mentioned quantities!

P1060 L27 "climate records" replace by "meteorological records" P1061 L4: "thawing permafrost...that can lead to increased catchment permeability..." is awkward wording. Better: "can lead to increased retention capacity of unfrozen ground"

P1061 L19-xx: "our results suggest that ...can fundamentally change the hydrologic responses" but you do not discuss mechanisms that would explain the observed trends, therefore you cannot really conclude about fundamentals. L21 "our observations indicate that sub-arctic mountain catchments..." this conclusion cannot be substantiated by the present study. You compare sub-arctic catchments of different glacier coverage not a mountainous to a low-elevation catchment. L25 "...attributed in large parts to the decreased size of the glacier" This statement is wrong, the mentioned attribution is never made. Reduced retention capacity may result from shrinkage of the firn area. How shrinkage of the glacier may lead to similar reduction needs to be discussed. How large is the area reduction of the glacier over the considered period?

P1062L8-10: "...catchment properties that promote fast runoff such as high-gradient topography, limited soil storage" It is not clear how invariable properties should be responsible for intensification of floods. Same statement is repeated in the conclusions P1063 L20-xx

The captions to Tables 6 and 7 should make clear to which period the presented statistics refer to.

Fig 6 should also show important glacier properties such as location of the equilibrium line and the firn area since these need to be discussed when interpreting the observed trends in summer discharge.

Supplementary material:

should be presented in the MS rather than in the supplement since the material is

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crucial to the discussion.

Table S1 does not present numbers "indicated by a star" as mentioned in the caption

The abbreviations of the climate indices in Table S2 should be explained in the caption.

#### References:

Hock, R., P. Jansson and L. Braun, 2005. Modelling the response of mountain glacier discharge to climate warming. In: Huber, U. M., M. A. Reasoner and H. Bugmann (Eds.): Global Change and Mountain Regions - A State of Knowledge Overview. Springer, Dordrecht. 243-252.

Førland E. And Hanssen-Bauer, I. 2000. Increased precipitation in the Norwegian Arctic: true or false? Climatic Change 46: 485-509.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 1041, 2012.

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