

## ***Interactive comment on “Brief communication: Historical glacier length changes in West Greenland” by P. W. Leclercq et al.***

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### **General**

We thank the two anonymous reviewers for their careful reading of the manuscript and their useful comments, which have been taken to heart in the revision of the manuscript. Most importantly, the revised manuscript also includes a comparison with the results of Mernild et al. (2012), Jiskoot et al. (2012), and Kargel et al. (2012), who present recent glacier changes in east Greenland.

Furthermore, both reviewers wonder why only 18 of the 80 glaciers studied in Weidick (1968) are included in this study. There are two main reasons for this. Firstly, it is not

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straightforward to identify the glaciers in the study of Weidick (1968) as coordinates are not included in Table 2 of Weidick (1968) and the resolution of the location maps is too low to identify the individual glaciers. We focused on the glaciers with the longer records and, more than 40 years after the original work, it was not always possible for Anker Weidick to identify the glacier with reasonable certainty. Secondly, not all identified glaciers could be used for the reasons mentioned in the article (surging, possibility to connect to the Landsat outlines). Despite the fact that the sample of 18 glaciers is limited compared to the original publication, we think the updated records provide valuable information. We are glad that the reviewers share this opinion.

Further details and replies to specific points are given below. We have copied the reviewer's comments and included our point-by-point reply in *italic*.

### **1 Referee 1**

#### **1.1 general**

Weidick (1968) is benchmark literature for everyone interested in glacier fluctuations in Greenland. It is, therefore, gratifying to see an update on parts of this work. The contribution by Leclercq et al. is also very timely as there is currently a lot of attention on recent glacier variations in length, area and volume in Greenland (as evidenced by the many contributions on this topic in 2012). However, one could have wished for a full research paper that included all 80 local glaciers from Weidick (1968) and not just 18 glaciers. The methodic reasons for excluding the remaining 62 glaciers are given by the authors (3493, 17-21), but it is still disappointing that the authors were unable to extend so many of the records. This said, it does not change the fact that this is a valuable contribution to the existing literature. The main reason for this is that there is currently very limited information on glacier fluctuations in the three regions covered by

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this study (Nuussuaq peninsula, Sukkertoppen, Julianehaab). Therefore, this study will remain valuable at least until detailed regional studies have been conducted in these regions.

## 1.2 Specific comments

(there seems to be a mismatch between page and line numbers in the online and printer-friendly versions at the end of the manuscript. The numbers below refer to the online version):

- 3492, 15-16: I am a bit uncertain on what Zemp et al. (2009) actually refers to. If it is the fact that “long-term direct measurements of mass balance are scarce”, then it is a very passive reference (i.e. to lack of something) and could probably be neglected to make space for more active references (see below; to keep within the 20 references cap for brief communications).  
– *Zemp et al. (2009) indeed supports the stated lack of observations, and is what the reviewer calls a "passive" reference. Following the reviewer's suggestion we have taken it out to make room for other references.*
- 3492, 22: The term ‘local glaciers’ has traditionally been used for decades to categorize all glaciers in Greenland from the Greenland Ice Sheet. However, with the recent focus on IPCC and global glacier classifications (e.g. GLIMS) the term ‘glaciers and ice caps’ is now widely used and has been applied to categorize local glaciers by authors, who are less familiar with the regional terminology. Therefore, I suggest that you insert something like “... (also referred to as glaciers and ice caps)”.  
– *We have inserted this as suggested by the reviewer.*
- 3493, 2: Two studies by Kargel et al. (2012) and Mernild et al. (2012) have recently been published in The Cryosphere, showing results of glacier recession

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rates of local glaciers in central East Greenland and Southeast Greenland, respectively. It is relevant to include them here and in the Results and discussion section. Both studies show rates of glacier retreat of 10 ma<sup>-1</sup>, which are comparable to your finding of 11 ma<sup>-1</sup> (3496, 13) and support your statement that the 20th century has been a period of widespread rapid retreat in Greenland (3496, 21-22).

– *Thank you for this suggestion. In the revised version we have included them in the introduction as well as in the discussion of glacier changes on Greenland over the last decades (see point below). However, we do not cite these paper here, as this paragraph deals with studies of long-term glacier fluctuations.*

- 3494, 12: Here and in the references, change Alstrom to Ahlstrom.  
– *done so, thanks for spotting this error.*
- 3495, 9-10: Only six glaciers are mentioned here, but in the Introduction (3493, 14) it says that seven glaciers were formerly tidewater glaciers. Please clarify.  
– *These six glaciers are the glaciers for which the connection between the length changes in Weidick (1968) and the position measured from Landsat images and aerial photography is based on the distance to the coast line. Not all of these glaciers were calving, and for some of the seven calving glaciers the connection could be made based on the 1953 aerial photograph used in Weidick (1968) as well as the GEUS outlines.*
- 3496, 8: What is meant by small? Insert the number.  
– *Sentence is revised and we have inserted the range of the mean length change as shown in Fig2b*
- 3496, 13: Include the standard deviation of the average retreat rate.  
– *We have included the standard deviations.*
- 3496, 14-15: Insert the retreat rate that is used for comparison, so that the reader does not have to look in the reference to find the number.  
– *The number of the retreat rate of Yde and Knudsen (2007) for the period 1953–*

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*2005 has been added.*

- 3496, 23: Replace (Dowdeswell, 1995) with (Weidick, 1968). Weidick (1968) finds an accelerated recession between 1920 and 1940 and relates that to the rapid air temperature increase between 1920 and 1930. This also spins back to what is mentioned in the Abstract and the benchmark value of Weidick (1968). In addition, the statement here is supported by Yde and Knudsen (2007), who find higher recession rates during the first half of the 20th century on Disko Island.  
– *Replaced reference, which also makes room for the other references (see point above).*
- 3496, 23: What I really miss here is a short paragraph that focuses on the recent decadal fluctuations of these glaciers from the end of Weidick's (1968) measurements to 2008/2010, including a comparison to recent fluctuations of other local glaciers in Greenland.  
– *We have included a paragraph with a comparison between recent glacier changes in west (this study) and east Greenland as presented by Mernild et al. (2012), Jiskoot et al. (2012), and Kargel et al. (2012).*
- 3497, 25: Sermikassak is misspelled.  
– *Although it is misspelled (it should be Sermikavsak instead of Sermikavask), the spelling of the glacier name is different from the one we use in our paper. The authors of this 1970 paper used the old spelling, identical to the spelling used in Weidick (1968). In this study, we use the modern spelling for the glaciers (i.e. often different from Weidick 1968). We have included the old spelling between brackets in the revised manuscript for more clarity.*
- 3501, Figure 2, caption, line 3: Record 4 should probably be Record 8 (cf. 3494, 22-23).  
– *indeed, thanks for spotting this.*

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## 2 Referee 2

### 2.1 General comment:

This brief communication presents length fluctuations since the 19th century for glaciers in the western and southern Greenland. New data from the second half of the 20th century, computed using aerial photographs and satellites images allow the authors to extend the records previously presented by Weidick in 1968. This updating is interesting as it allows to put in perspective the current changes with the trend at the pluri-decadal/centennial scale, and confirms that the first part of the 20th century experienced the most important retreat rate in this region of the world. The paper is clear and well written and deserves to be published. I just have some minors comments that will help to clarify few points.

### 2.2 Specific comments:

- P. 3493, L. 14-15: Add a reference at the end of the sentence.  
– *The source of information on these particular glaciers is Weidick (1968). Reference is included in revised version.*
- P. 3493, L. 17-21: If the mentioned points are the reasons why only 18 glaciers (within the 80 studied by Weidick (1968)) were considered in the present study, it has to be specified. If not, what are the reasons for not studying more glaciers of the Weidick sample?  
– *The 18 glaciers are the selection of identified glaciers from Weidick (1968) that could be extended using the remote sensed glacier outlines. The main reason why not all 80 glaciers are studied is that the glaciers needed to be identified (see also general remarks).*

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- P. 3494, L. 1: If the reference Paul et al., 2012, is still under revision, it has to be removed. If this paper is accepted, do not forget to update the reference.  
– *The paper is accepted and the reference will be updated in a revised version.*
- P. 3494, L. 21-25: In this sentence, the part “which were not included in Weidick (1968),” can be removed. It is obvious that all the reference quoted in this sentence could not appear in Weidick 1968 because they are all more recent. Also, this sentence should be re-written in a sake of clarity.  
– *“not included” refers to the glaciers that were not included in Weidick 1968, therefore the Motzfeldt O and Motzfeldt W glaciers do not have a loc no in Table 1. We have rewritten the sentence to be more clear.*
- P. 3496, L. 8: According to your interpolation used in Fig. 2a, the glacier nr. 12 (Saarloq) also presents an important length change during the 2nd half of the 19th century, so that Assakaat is not the only one. Please clarify.  
– *As the second point in the length record of Saarloq is not until 1930, 70 years after the first in 1860, we think it is likely that most of this retreat happened during the 20th century. However, a substantial retreat in the 19th century cannot be excluded because of the lack of observations. The interpolation is not a replacement for observations, and its distribution of the length change over the gap in the record should not be interpreted as if it represents reality. We have revised the text on this point.*
- Figure 1a: You should named the three regions of interest (those cited P. 3493, L. 11-13), or at least put some coordinate marks on the map.  
– *We have included the region names on the map in Figure 1a.*