

## ***Interactive comment on “10,000 years of melt history of the 2015 Renland ice core, EastGreenland” by Tetsuro Taranczewski et al.***

### **Anonymous Referee #2**

Received and published: 24 June 2019

#### General comments:

As the authors point out, melt records are sparse for the Greenland Ice Sheet, and therefore the Renland melt record presented in this paper will be a great contribution to the collection of ice core paleoclimate records. In order to be useful, though, the time spans as well as the claims of shifts in melt/warming trends need backing by statistical analysis.

This manuscript would also be greatly improved by adding more detail to all sections. Below, I have pointed out the most confusing sentences that require more information. Since the manuscript length does not run too long, all sections could be improved by removing all vague statements.

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Lastly, the English in this manuscript needs improvement, especially within the discussion and conclusion sections. The authors also need to add transitional words or phrases at the beginnings of sentences, connecting words or phrases (e.g. “and,” “as well as,” etc.) within many sentences, and commas after the transition words that already exist, in order to make the manuscript more readable. There are also many cases of mixing past and present tenses in sentences, which need to be corrected.

#### Specific comments:

**Abstract:** The statement in the final sentence of the abstract is not supported in manuscript below. Please add discussion, where appropriate, to specifically support the claim that the 2012 melting event was the strongest in past 500 years.

#### Section 2:

1) On Page 3, Line 3: This first sentence of the paragraph is a general description of a result, and therefore is more appropriate for the results section than the methods section here.

#### Section 3.1:

1) On Page 4, Lines 4-5: What do you mean by ‘allocate’ here? Do you mean that you count the number of melt layers between the depths of the annual layers?

2) Is the depth-age scale impacted by the frequent formation of melt layers at a site like Renland? If so, how is that incorporated into your error estimate of AMR?

3) It has been shown that large melt events often have multiple ice lenses/melt layers, and that some of those layers penetrate deeper than that year’s firn layer (e.g. Nilsson et al., 2015). How do you account for these events depositing a melt layer in the previous year’s firn layer? (I see now that you briefly mention this potential source for error in Section 5.2, but I think it’s worth mentioning this earlier in the paper here as well for clarity)

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Section 3.2:

1) The fourth and fifth sentences in this paragraph contradict each other (Lines 4-6). Consider rewriting this paragraph to make it more clear that there's a difference in the deformation/thinning rates of the firn layers, but that the thinning rate does not affect the thickness rate in the ice layers below the firn-ice transition depth.

2) In the second paragraph, it is unclear how the melt layer thickness distributions aid in calculating the depth at which a layer will thin to below 0.2 cm. Please explain this method of analysis further here.

Section 4.1:

1) What figure shows evidence for the statement "The melt records...further show variations in time of the distribution..."? Also, what does this mean? This is a confusing statement.

2) This would be a good place to describe the meaning of the variables in the legend for Figure 3, and what the values of those variables indicate.

3) Is this a statistically a peak in AMR in 1917? Without any statistics, it's hard to differentiate whether that peak is more significant than the increases in AMR during the 1940s or the 1970s shown in Figure 4. Again, it is hard to compare the recent AMR trend (since the mid-1990s as you state) to 1917 without any statistical analysis.

Section 4.2:

1) There is no black line in Figure 5a, are you referring to the green line in Figure 5a in the first sentence? If so, also correct this labeling within the figure caption.

2) Is the year 1860 when the AMR statistically rises above the background variation in AMR? Statistical analysis to needed to back up this statement.

3) The 1990 warming trend the authors state here isn't visible in the temperature anomaly record shown in Figure 5b, where the blue line (Renland) looks to be at a

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plateau and the pink line (Greenland) looks to be decreasing in the 1990s. Please further describe how you found a warming trend at this time.

4) Again, a statistical analysis of the warming and melting trends will allow the authors to state which periods of time in the records were significantly warmer or cooler.

Section 4.3:

1) In the section header, use 8000 BCE instead of -8000 CE to be consistent with the rest of the text.

2) Since the authors corrected the AMR for ice loss in Section 4.2, they should clarify this first sentence of this section that they are now considering the full record without the ice loss correction.

3) Again statistics on the peak of AMR in Figure 6 will significantly help the description of the peak/anomalous years in this record. Otherwise these statements in Section 4.3 are far too vague.

Section 5.1:

1) In the second paragraph, "This corresponds to a 20% difference..." What difference are you referring to here?

2) Again statistics are needed to compare the different smoothing records before making a statement that "This proves our record to have a resolution and representativity on the decadal scale..." Also, representativity is not a word.

Section 5.2:

1) What exactly is the correction used for the corrected AMR curve? Please describe this in greater detail.

Section 5.3:

1) What does the phrase "much less findings" mean on Page 10, Line 18? This sen-

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tence here (Lines 16-20) is a run-on sentence and is very hard to follow. Please re-structure.

2) Please provide justification for why you believe that your record “has a higher accuracy and is more reliable,” beyond stating that you found more melt layers than Alley and Anandakrishnan (1995) did.

3) On Page 10, Line 21, which “observed change of the trend from the warmer to the cooler period. . .” are you referring to? Please be more specific in these statements.

Section 6:

1) Again, it is hard to accept sentences stating proof of correlating trends in records, or accuracy of this method, without any statistical analysis to back up these claims.

Figure 1: It would be helpful to split the inset map of the entire Greenland Ice Sheet and the zoom in map of Renland into a 2-panel figure, so that the geography of the western portion of Renland is visible.

Figure 2b: Are the blue lines indicating melt layers identified visually through the line scan images, or are they identified because they're spikes in the density record? Also, this panel of Figure 2 is never referenced in the text. Consider referencing it towards the end of the paragraph that ends on Page 3, Line 2.

Figure 3: Please add the description of the three variables found in the legends in the figure caption. Also, in the third panel (for Core S2) is the value for the 4th bar from the left 45, or is this data point cut off? Consider increasing the range of the y-axis to make this clearer.

Figure 4: In the figure caption, the phrase “the onset of the present years warming trend” is imprecise and vague. Please clarify what this is referring to.

Figure 5:

1) In panel 5a, you do not describe what the green line represents in the figure caption.

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Also, what does the value '0.32' indicate right next to the legend?

2) In panel 5b, it would be helpful to make both of the axes the same color as the lines of their respective records shown within the figure. To distinguish between the AMR and AMR corrected for the left, and Renland versus Greenland for the right, you can use solid and dashed lines.

3) Lastly, it is very difficult to compare the trends of all of the variable in Figure 5a and 5b. Since you spend some time describing the trends since 1860, consider adding another panel to this figure to enlarge that portion of both plots (1860-present) for easier analysis of the data presented.

Figure 6:

1) Why is the annual melt ratio record denoted as SWE\_ML/SWE\_total on the y-axis here instead of the M\_ML/M\_total in Figure 4 and 5?

2) What do the 0.6 and 1.0 values at the top of the figure indicate?

3) What do the red bars indicate in the figure?

4) Which axis relates to which part of the figure?

List of Technical Corrections:

Page 1, Line 5: comma needed after 'rates'

Page 1, Line 17: it should be 'thickness' instead of 'thicknesses'

Page 2, Line 1: “We now conducted” is an awkward phrase because it mixes past and present tense. Consider changing this to “We conducted,” or “We now conduct.”

Page 2, Line 4: remove space in front of 'e.g.'

Page 2, Line 8: The phrase “in addition” is awkward because it doesn't state what it's in addition to. Consider changing this to “. . .of the layers also takes place.”

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Page 2, Line 10: Switch the order of this initial phrase to instead say something like “From May to June during the summer of 2015.” Also, here’s another example of mixing past and present tense. Please correct the verb tense throughout the paper.

Page 2, Line 21: Stay consistent with capitalizing (or not) “Eastern Greenland” throughout the text

Page 2, Line 28: Write out x-ray micro-computed tomography before using the ‘ $\mu$ CT’ abbreviation for the first time

Page 2, Line 31: This is not clear. At which depth does the core density reach 850 kg/m<sup>3</sup>?

Page 2, Line 32: It is awkward to start a sentence “S1 and S2. . .” Consider changing to “The S1 and S2 cores were. . .”

Page 3, Line 10: The past tense is needed in the second sentence.

Page 4, Line 5:  $\mu$ CT is abbreviated differently here than above. Keep the abbreviation consistent throughout the manuscript.

Page 4, Lines 6: the sentence is missing ‘and’ before “their respective”

Page 4, Line 10: should be ‘amount’ (singular)

Page 5, Line 2: a comma is needed after ‘transition’; In addition to what? It is awkward to have the phrase “in addition” without saying what is being compared.

Page 5, Line 5: Remove “but” from the beginning of this sentence

Page 5, Line 10: the phrase should be “the degree to which” instead of “to which degree the”

Page 5, Lines 11-15: This is a run-on sentence. Please reword and break into multiple sentences.

Page 5, Line 25: What does “the resulting merged catalog” refer to? This transition

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doesn’t make sense without further information.

Page 5, Line 27: “and” or “as well as” needed after “. . .main core,”

Page 7, Line 5: Be consistent with your use of CE throughout the text.

Page 7, Lines 9-10: This last sentence does not make sense. Please reword.

Page 8, Line 10: “hence” is not the right transition word here.

Page 8, Line 11: “ti” should be “to”

Page 9, Line 10: Should be “an 11-year. . .”

Page 9, Line 24: restate the figure number instead of saying “same Figure”

Page 10, Line 5: need to add “for” between “compensate” and “these”

Page 10, Line 9: should be “centennial” instead of “century”

Page 10, Line 14: “Period” needed after “Medieval”

Page 10, Line 25: wrong verb tense here again

Page 11, Line 20: the year is missing from this reference

Table 1 Caption: The second sentence is hard to understand. Consider rearranging the sentence to something like “The number of melt layers are listed in. . .” Also, the number of melt layers are listed in parenthesis in your table, not brackets.

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Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2018-280>, 2019.