

*We thank the reviewer for the careful review below and for the many points which have helped to improve the manuscript. We hope the response below addresses all the points satisfactorily.*

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**Interactive comment on “Centuries of intense surface melt on Larsen C Ice Shelf” by Suzanne**

**Bevan et al.**

**E. Thomas (Referee)**

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The paper presents flowline and firn data density model data to interpret five 90m boreholes on Larsen C ice shelf. The study is timely, well written and clearly structured.

I think the paper should be published following minor revisions.

There is a lot of reference to recently published papers and even a reproduction of a figure from a study published this year. I have not read these works but the author's state that Ashmore et al., 2017 concluded that spatial melt has been ongoing for decades to centuries. Perhaps the authors could make it clear what is new about this study (ice flow modelling? dating melt events?), demonstrating that this study builds on existing research but contains novel insights.

*Point accepted and (as in our reply to Reviewer 1) we have tried to make this clearer in the introduction by stating that the description of the ice units given is a summary of Hubbard et al. (2016) and Ashmore et al. (2017). We have also changed the concluding paragraph of the introduction to*

*‘Ashmore et al. (2017) concluded that the significant quantities of refrozen ice within the boreholes suggests that intense melt is spatially pervasive and has been ongoing on LCIS for decades or even centuries. In this study we use a flowline model to investigate where and when various units of melt-affected ice observed within the Cabinet Inlet and four other boreholes originated, relate the origins to past local climate, and estimate how much of the ice shelf is likely to be affected.’*

One area that could be improved is relating the ages of these melt events to the wider climate of the region. You mention instrumental evidence for warming beginning in the 1950s, but there is ice core evidence from the central and southern Antarctic Peninsula that this is part of a longer 20th century trend (eg Bruce Plateau and Gomez ice cores). In addition, the Ferrigno ice core revealed warming trends during the mid 18th and 19<sup>th</sup> centuries that would support your findings for melt events during those periods.

*We had mentioned the Bruce Plateau core but have now added reference to the Gomez and also Ferrigno ice cores in discussing the 20<sup>th</sup> century warming. We have also added the following to the discussion of the 18<sup>th</sup> century warming. Thank you for the suggestion.*

*‘Although the Ferrigno ice core indicated a warming in the second rather than first half of the 18th century (Thomas et al., 2013) it reveals, along with the JRI core, that the AP region has*

*experienced a decadal-scale variability in air temperature over the past 300 to 1000 years of a similar magnitude to the 20th century warming.'*

Relating to this, there is growing evidence that SMB on the AP has been changing dramatically during the 20th century. Admittedly the majority of the ice core records are from the western side of the Peninsula, but the snow accumulation records here are strongly influenced by changes in westerly wind strength (eg SAM), which is driving changes in foehn winds and impacting melt on Larsen C. My query therefore is has the snow accumulation on the eastern side of the AP remained stable during the past 300 years? And if not, how would that influence the flowline models and age estimates? Could this explain some of the discrepancies you mention (page 8)?

*This is an interesting point but the discrepancies regarding dates in the inlet regions are more likely to result from difficulties in modelling accumulation downstream of steep topography (as well as not having accounted for lateral meltwater influx and vertical percolation). Since submitting the manuscript an observationally constrained improved reconstructed SMB field has become available (Kuipers Munneke et al., 2017). Although this increases SMB estimates over most of each flowline we have chosen not to use it as explained in the paragraph below which has been added to Section 2.3 Surface mass balance.*

*Since this paper was reviewed for publication, an observationally constrained improved reconstruction of LCIS 1979–2015 mean SMB has become available (Kuipers Munneke et al., 2017) which exhibits values ~10% higher than our upper uncertainty bound along each trajectory. Despite this apparently improved dataset being available prior to final publication, we have not updated our analysis because the new dataset will not significantly impact on our results, discussion or conclusions, and is probably not an improvement for the context in which we are using it. In short, we are necessarily approximating a long chronology (more than 300 years) of values using a relatively short contemporary SMB field. In this context, the new reconstruction will not offer an improvement especially as there is some evidence for accumulation rates having increased by over 10% in Antarctic coastal regions since the 1960s (Frezzotti et al., 2013), and therefore the lower SMB values from our original dataset are probably a better representation of the longer-term estimate.*

Technical corrections: Abstract – “experience”, change to “experiencing”

*Thank you, changed.*

“..the boreholes sample ice that....” consider rewording?

*We would like to keep the wording as it is.*

Page2, ln 26 – duplication “in which”

*Thank you, changed.*

Page3, ln 18 – “additional”, unnecessary wording

*We have kept in ‘additional’ although this paragraph has been reworded slightly in addressing reviewers’ suggestions that we make clearer what is existing research and what is new.*

Page 4, - title capitalisation “Flowline model”

*Thank you, changed.*

Page 5, version of RACMO? 2.3? Perhaps define eg “...the Regional Atmospheric Climate Model (RACMO2.3).”

*Done.*

Page 5, In 29 the estimates of 870 and 588 years are from this study?

*Yes, have added ‘...we calculate...’ to make it clear.*

Page 19 delete “along”

*‘along’ is needed but we have hyphenated ‘along-flow profiles’.*

*Please note that following the calving event in July this year we have now changed P2L10 to*

*‘In July 2017 a rift, which began propagating from the south in 2014 (Jansen et al., 2015; Borstad et al., 2017), caused ~10% of the ice shelf area to break away (Hogg and Gudmundsson, 2017).’*