

## ***Interactive comment on “Thickness of the divide and flank of the West Antarctic Ice Sheet through the last deglaciation” by Perry Spector et al.***

### **Anonymous Referee #1**

Received and published: 3 August 2019

Spector et al. report new data from the Weddell Sea sector and from the Ross Sea-Weddell Sea ice divide in West Antarctica. The last glacial maximum (LGM) highstand is determined from the elevation of young (post-60 kyr BP) Be-10 and saturated C-14 nuclide concentrations, and modelled scenarios of past ice thickness change at the sites. The authors then interpret these respective ice thickness changes to record a combination of snowfall accumulation and dynamic thinning through the deglaciation.

The paper is generally well-written with clear figures and adequate provision of supplementary data. The data are new with robust lab, measurement and calculation procedures, and the approach to determine ice thickness change from these data is novel. The data are worthy of publication and the conclusions would be of interest to the readers of The Cryosphere. However, I have some concerns that need to be addressed,

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which have potential implications for the reliability of the paper's conclusions.

Main comments:

### 1. Treatment of Be-10 and C-14 data

As the authors point out, C-14 has an advantage over Be-10 owing to the shorter decay time, which prevents most inheritance from pre-exposure from being recorded in the sample concentrations. At Pirrit Hills, the Be-10 ages are used to indicate when the local ice surface reached a highstand (e.g. before 18 kyr BP; page 6, lines 19-21). Yet, it is noted for other studies that the use of C-14 has highlighted that approx. LGM Be-10 ages are not reliable indicators of the highstand (page 7, lines 3-5). The authors do not acknowledge the possibility that their Be-10 ages may similarly record minor inheritance, which would therefore make them minimum age estimates and less reliable highstand indicators.

Samples with C-14 concentrations that are indistinguishable from saturation are used to delimit the LGM highstand at Whitmore Mountains (e.g. page 7, lines 8-9). The Nichols et al. TCD paper (which shares authors with this paper) discusses how high C-14 concentrations can result from analytical and geomorphic issues – what is there to say that any of these saturated samples do not suffer from the same issues? Can we trust this approach for delimiting the LGM highstand?

The delimitation of the highstand has implications for the interpretation of ice thickness change (e.g. which modelled scenarios are ruled out).

### 2. Calculation of ice-cover and exposure history scenarios

There is little discussion about the production rate in the method (page 7, line 31 to page 8, line 24). Do these model scenarios account for sample-specific production rate differences? It appears that production is calculated for spallation only, without any mention of production from muons. Muonic production near the surface is important for C-14 (Lupker et al., 2015; Hippe, 2017) – is this accounted for in these calculations?

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Minor comments:

Page 1, lines 10-11 (abstract): The final sentence would be better as a conclusion/implications. Perhaps something about how the model(s) calibrated with geological observations performed best.

Page 1, lines 22-23: Got a suitable reference for this sentence?

Page 2, lines 2-4: Is there evidence of atmospheric temperatures being warm enough to induce thinning in this region of Antarctica?

Page 3, lines 19-20: Or, similar to what you mention later, the abundance of debris may relate to debris source (i.e. the ice sheet had access to more debris when near to its highstand).

Page 3, line 33 to page 4, line 1: This is an important point, but the data to support it has not been published. This point should be removed or the data included in the Supplement with suitable description and analysis to reach this conclusion.

Page 4, lines 23-27: As above. Is it necessary to include the data if the data "are not relevant to this paper"?

Page 6, lines 6-7: Confusing sentence. Is CRONUS-A from the Whitmore Mountains or the McMurdo Dry Valleys?

Page 7, lines 11-14: Overly complex sentence which could be made simpler for the reader.

Page 7, lines 16-17: Can you provide a reference for the typical West Antarctic snow density?

Page 9, lines 13-15: It is dangerous to use ice sheet models to support interpretations of data, and then use that data to assess the quality of the models. Reconsider using models to interpret the data.

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Page 9, line 35: “ice” typo.

Page 10, lines 9-10: Most of these cited studies do not record grounding-line changes.

Page 11, lines 16-17: Yes, perhaps this suggests that the grounding line retreated too early, but, as you say previously, thinning is also dependent on changes in the accumulation rate.

Page 12, lines 1-3 and lines 15-16: Why not compare to other models calibrated with geological observations (e.g. Whitehouse et al., 2012; Briggs et al., 2014)? This would strengthen the conclusion that the best performing models are calibrated with geological observations.

Figure 7: You should explain what the vertical dashed line represents in plot c.

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