Review of: High resolution boundary conditions of an old ice target near Dome C, Antarctica, Young and others, TCD doi:10.5194/tc-2016-169, 2016

This paper largely concerns the presentation of new aerogeophysical data acquired in the vicinity of Dome C, Antarctica, as part of a concerted international effort to locate a site for coring ice older than 1 Ma. It begins by giving some background context on the "search for the oldest ice," and justifies well the acquisition of aerogeophysical survey data across the Dome C region to this purpose. The paper then describes the survey that was conducted across the region in 2015/16 in response to this need, and presents an impressive new map of the bed, as well as incorporating a valuable discussion of the uncertainties of the data.

The paper certainly presents data that are worth publishing and that will be of high interest to a wide range of readers, most obviously in the ice coring community but also more generally – for example radioglaciologists and geomorphologists will find the analysis of radar uncertainties valuable. Not for the first time, the ICECAP team have acquired a hugely impressive product in a highly remote part of Antarctica; a highly commendable undertaking. The figures are produced to a high standard, albeit I suggest some amendments in my specific comments.

However, there are two aspects to the paper which I recommend need major attention:

Most importantly, there is too little analysis/interpretation/discussion of the data. In its current form, and not including the material on uncertainty analysis (which I think is misplaced in the structure; see next comment), the absence of a discussion of the data renders the paper little more than a dataset presentation paper, possibly more suitable for the journal Earth System Science Data which publishes datasets without the requirement for detailed analyses. Given the paper's set-up that the survey was undertaken to help site the possible new ice core, the fact that it doesn't offer a detailed reflection on the new insights it has contributed towards honing in on the oldest-ice coring site seems a big miss. Fundamentally the paper just closes down too rapidly once it reaches the results section (just as I was getting most interested….). I also think the bullet point conclusions section needs consideration: I make some suggestions about this in my Major Comments below.

Secondly, and this is a lesser, but related, comment to the above, the paper has some structural problems. The clearest example of this is Section 5, the uncertainty/crossover discussion: this is actually a very valuable aspect to the paper but comes across as rather ad hoc because it is written entirely within an isolated section and not treated as part of the overall methods/results/[discussion]. I also suspect its importance will be overlooked by any but the most thorough readers because the abstract/conclusions only say the issue is investigated in the paper, rather than summarising the findings. There are also a few places where a reordering of figures might help.

Thus – for the importance of the topic and the clear worth of the data, I would really like this paper to progress, but I feel it needs some reworking as regards the presentation, especially with regards to closing the loop in terms of what the data now offer in terms of identifying an "oldest-ice" site. In its current form, the paper significantly undersells the importance of the data collected and, indeed, the efforts that have gone into collecting it.

Major comments

My main comment is that I think the paper needs some restructuring and expansion from Section 5 onwards (and then reflecting this in a revised and more detailed abstract).

Most importantly, I think that the paper requires a Discussion section between the sections currently entitled "6. Results" and "7. Conclusions." There is clearly lots of potential to do all sorts of exciting further analyses of the new aerogeophysical data collected for this study, and I do not advocate the authors do more analysis per se (presumably they have plans for follow up papers on the data) – BUT I do think they can make some more of the dataset they present here already. Can they present an assessment as to whether the new data have helped determine whether or not Candidate Site A is a better/worse candidate site than was thought before the 2016 survey? I think there is also some potential to explore a little further how the issues surrounding different uncertainties/errors for datasets of different provenance are dealt with in producing the combined product Figure 7. It would be valuable to see just the data acquired from 2016 presented as a bedmap in isolation of the other datasets, as well as the bedmap produced with the combined datasets.

I also recommend that the authors consider how they can reframe all the material in Section 5 into relevant methods/results/discussion sections (the fringe benefit is that some of this material can essentially form one section of the Discussion the paper so desperately needs).

I recommend the authors then rewrite/revisit their overall conclusions and abstract so that they state in both of those sections the findings that result *directly* from the new dataset and analysis. The current conclusion 3 especially only states a fact that the authors tell us they already knew before they collected the new data presented here.

Minor comments

The above major comments now aside, I would like to emphasise that I found most of the paper well written and the figures of good quality. I don't think the authors need to do much to the opening of the paper, as they may infer from the selection of comments below.

Minor suggested global edits:

There should be no apostrophe in 1970s, 1990s etc.

Is there any need for the acronym CST for Concordia Subglacial Trench? You don't use CST that often (unless an expanded Discussion will use it much more) so it just seems an unnecessary acronym.

Introduce hyphens into "along-track, "across-track," "off-track," "range-compressed," "pulse-limited"…

Ensure "crossover" consistently expressed as one word.

Sections 1 and 2:

P2, L1: Change "criteria" (plural) to "criterion" (singular).

P2, L4: I suggest you don't need the aside about these features being called "blobs." You don't refer to blobs elsewhere in the paper.

P2, Section 1, final paragraph: The current wording is vague about whom the "European-led group" are, and includes some extraneous detail about the logistical delay to the survey - you have my sympathy on the latter, but it doesn't affect the findings of the paper. This paragraph just has to focus on the purpose of this paper, which I suggest is along the lines of: "In this paper we present the results of an aerogeophysical survey specifically targeting the candidate old-ice access sites that was conducted in January 2016. We show … [now state what the paper fundamentally shows and adds to existing knowledge, e.g, a new map of the basal topography, and preferably one or two ways in which you use the data more than just

presenting a map, i.e. what do the new data add to identifying an old-ice access site? As a further example of the new data's uses you could also state that the new data offer insight into the meaning of uncertainties in RES data analysis.]

Figures 1 and 2; wherein currently Figure 1 is first referenced within the text in the opening line to Section 2, essentially just to locate Dome C:

To aid overall readability of Section 2 and the inevitable flicking between text and figures, I think you could combine Figures 1 and 2, and add a new panel, so that the figures are more readily intercomparable by the reader and introduced more logically as the material is discussed in the text. Essentially, following the text, the first result I want to see is just the surface ice topography (as per Section 2.1, paragraph 1), then I want to see the pre-ICECAP-surveyed subglacial topography (as per Section 2.1, paragraph 2), then I want to see the Van Liefferinge model results (as per Section 2.2). So I'd suggest a new three-panel Figure 1 covers the bases in that order, i.e. panel (a) shows pre-ICECAP surface topo; (b) shows pre-ICECAP subglacial topo, and panel (c) shows Van Liefferinge results. It would be really useful if every panel had superimposed the 5x candidate ice-core sites from Van Liefferinge as well as Concordia. The figure would also need still to include an inset showing the general location of Dome C. It would also be valuable on at least one panel (subglacial topo perhaps) the locations of subglacial lakes from the latest inventory marked.

W.r.t. the existing caption for Fig. 1, the acronym OIA is unexplained in the main text at the stage I first read the caption, and I suggest the sentence referring to the red line is reordered as: Red line shows radar profile acquired in 2011 and shown in Figure [would now be 2, if you follow my suggestion to combine Figures 1 and 2].

A minor point on the existing Fig. 2 – the blue contour line to the left, presumably denoting surface elevation 3200, could do with labelling within the figure.

P2, L20: At end 1st sentence of this section, just point reader to relevant figure showing surface topo.

P2, L20: Change "was" to "were" and explain acronym "INS."

P2, L22, 31 & 32: In these contexts, no need for "dome" to have capital "D."

P2, L25: No need for phrase about Dome C Lake District.

P2, L32: At end sentence "…northward flow" point reader towards relevant figure (currently Fig 2, but as per above comment suggest this becomes Fig 1b).

P3, L1-2: The sentence introducing the "broad channels" doesn't make clear whether the broad channels are surface features, bed features, or possibly both, and it would be improved if some idea of the dimensions of the relevant features were included. Could the authors consider showing these features explicitly in my suggested new panel Fig. 1a?

P3, L9-14: There's some unnecessary information here about surveys which aren't used for this paper. I also suggest, for structural reasons, that you introduce the 2011 data in Section 2.2 (see comment below). Thus I think you could just excise these lines.

P3, L16: Remove "have".

P3, L17: sp. teleseismic

P4, L3: change to "[none]….sites ***overlaps*** with ***the***…"

P4, L13: Here is where I think you could say, for the first time, that ICECAP/HiCARS2 profiled across the Candidate A site in 2011. I suggest you also find alternative wording to your use of “core” in the current sentence.

Figure 3: Just a minor point – why have distance going from right to left? Intuitively it would just seem preferable to have this axis reversed, if only to adjoin the description of the englacial layers diving off a cliff as mentioned in the main text. Admittedly this is not a major issue.

In the caption to Figure 3: typo: “along” rather than “alone”. The caption should also mention that the profile location is shown on Figure [1c…?].

Sections 3 and 4

I suggest that both of these sections essentially outline the “Methods” or “Methodology” and could be titled as such in a single section.

I think Section 3 misses an opening sentence or two to remind and re-orient the reader that you are now going to focus on data collected in 2016.

Table 1, Row 2: sp. Scalar

You introduce/describe in this section and list in the table some instruments whose data are not apparently used at all within the paper.

P6, L4: reverse order: “constrain better”

P6, L8-9: Unnecessary and could just be cut.

P6, L12: “…helped ***to*** refine…”

P6, L13 and throughout Section 4.2: “…data ***were***…”

P7, L9: “…[hyperbolae]….characterize…” i.e. not characterizes with an “s”

P7, L17: Move comma: “…column and, using…”

P7, L18: Reverse “not” and “to”…. We choose not to apply…”

I’m surprised to see no mention of the assumed radiowave travel speed in Section 4.3. In general, though, I completely approve of the no frills approach to the data processing in the paper.

I do not provide minor comments from Section 5 onwards following my view that they require major revision.