I thank the reviewers for their detailed comments (and complements!). I respond to the suggested changes below in bold.

Response to Anonymous Reviewer #1

P.1, L.10 "ice of less than 3000 m" -> "ice thickness of less than 3000 m"
> **Done**

P.5, L.18 "shown in green on Fig. 3" I did not find green in this Figure. Perhaps the authors meant Fig. 2c.
> **Reference fixed**

P.6, L.7 Again, Fig.3 should be Fig.2c. Figure 3 does not seem a reconnaissance line.
> **Reworded to: *"Initial radargrams such as that shown in Fig. 4 (upper) show considerable small scale bed roughness, not captured by Bedmap2."***

P.7, Figure 3 bottom Is "North" projected north or true north?
> **To the caption for the upper radargram reworded to "*Geographic south is to the right, Dome C and geographic north is to the left,* " and added to the caption for the lower "*…and orientation is the same as above.*"**

P.8, L.3 -6 It was hard to understand directions of XY (which is X, which is Y?) and geographical directions (projected or true?).
> **Reworded to "*with 110 km long longitudinal to slope 'Y' survey lines at separations of down to 1 km cutting across the ice divide, and ~65 km long transverse to slope 'X' tie lines*"**

P.9, bottom line of caption of Fig. 4 "Projection for Easting ... Polar Stereographic" This sentence does not provide readers if they use true directions or not.
> **Added "and viewed in the projected Northing plane (lower, looking across the ice divide) and projected Easting plane (upper, looking along the ice divide)."**

P.11, Table 2 and Table 3 I am confused because I did not find consistency between Table 2 and Table 3. I mean, "mean deviation" of two tables should agree with a relative manner in principle. But it seems that they do not agree with each other at all in a relative manner. Am I misunderstanding something?
> **Reworded captions to "*mean offset and standard deviation*", added sentence to the main text: "*In all cases, the standard deviation of the trackline data compared to the OIA-only grid was better than the comparison to Bedmap2 (see Table 3), likely related to the loss of spatial resolution in Bedmap2.*"**

P.11, footnote "*" of Table 3 It seems that the difference is from Bedmap2 here, and not from the OIA-only grid. Am I misunderstanding something?
> **Fixed**

P.12, 3rd and 4th lines in the caption of Fig. 5. The authors wrote, "show that all of the candidates aside from the innermost portion of Candidate A lie over regions of high driving stress". I do not see so on the map. I think this statement needs to be

reconsidered.

Reworded caption to "… *show that all of the candidates aside from the innermost portion of Candidate A lie over regions of* relatively *high* (20-30 kPa) *driving stress***"**

Response to Anonymous Referee #3
Minor Comments:
P1, L2-4: "New ice thickness data derived from an airborne coherent radar sounder was combined with unpublished data that was in part unavailable for earlier compilations, and were able to remove older data with high positional uncertainties."
Put this statement in active voice: "We combined new ice thickness data… and we were able to remove…"
Done
P1 L18: "…with and approximately 400 ka transition…" Should be "an" not "and".
Done
P2 L3-4: "(1) low accumulation, to restrict vertical thinning rates and increase temporal resolution…" The effect of surface accumulation is a bit more complex than that. While it is true that low…
Changed "temporal resolution" to "temporal coverage".
P2 L4-5: "(3) proximity to an ice divide to limit vertical thinning rates…"
Removed "vertical thinning and"
P2 L7-8: "Items 1 and 2 interact, as low accumulation limits the advection of cold, requiring low geothermal heat flow to offset melting."
Rephrase to more clearly describe the underlying physical processes: "Items 1 and 2 interact, as low accumulation limits the downward advection of cold surface temperatures, requiring low geothermal heat flow to prevent melting."
Rewritten as suggested
P2 L8-9: "Items 3, 4, and 5 lead to the somewhat contradictory requirement of a flat subglacial mountain." Only items 4 and 5 are involved in the contradiction.
It is the relatively high ice of the ice divide, along with the limited ice thickness that forced the existence of a mountain to satisfy this criteria. Rewritten as follows: *"Items 3* (implying elevated ice surface height)*, 4* (smooth subglacial topography)*, and 5* (implying limited ice thickness) *lead to the somewhat contradictory requirement of a flat subglacial mountain. Given the significant logistical requirements of ice core recovery, another important criterion for any old ice site is accessibility."*
P4 L1-2: "…implying that an ideal old ice target may require a very flat ice-bed interface…" What about roughness along the flow path back towards the dome? The old ice near the bed…
Added "around a flowline tracing back toward the ice divide"
P5 L 14-16: "The size of Candidate A compared to the other local candidates also makes

it more likely that the Van Liefferinge and Pattyn (2013) model captured basal temperatures correctly."… A possible rephrasing that navigates this distinction is: "The size of Candidate A compared to the 5 km model grid size makes it more likely that the Van Liefferinge and Pattyn (2013) model captured basal temperatures correctly, while the small size of the other candidates relative to the model grid makes them less reliable."

Reworded to: "*The size of Candidate A compared to* the 5 km model cell size…"
P5 L31-32: "...bedrock trends are significantly disagree..." Remove "are".

Done

P6 L3-4: "...a 15 km offset along-track would be required to reconcile the surface slope structure and Bedmap2 bed elevation data at this location." What about an across-track offset? Is one offset intrinsically more likely than the other for older navigation systems?

Added the following: *"(as the flight line crosses the trough, the interpolated topography is not sensitive here to cross track errors on this line)"*

P6 L15-16: "The identification of subglacial lakes is complicated by variations in englacial attenuation that modifies the strong radar reflection due to an ice-water interface (Carter et al., 2007)." A better reference here would be Matsuoka, 2011.

Added Matsuoka, 2011

P 8 L8: "...and a second line to constrain better an oblique topographic ridge..." "constrain better" should be "better constrain".

Done

P 9 L14-15: "To obtain ice thicknesses, we systematically select a window around the earliest bed return, and then automatically select the best fitting pulse waveform within that window (assumed to be a paraboloid power profile), for both the surface and the bed." By a "paraboloid power profile", am I right in interpreting this to mean that you assume that the echo power has a Gaussian profile on a linear scale, which becomes a parabola on a logarithmic (dB) scale?

Added to radar processing section: "*and the logarithm of signal power was displayed for manual interpretation.*", and reworded this location to: "*(assumed to be a paraboloid power profile in decibels)*"

P 10 L 13-14: "Regions with a sustained specularity content greater than 0.2 were classified as subglacial lakes." What do you mean by "sustained"?

Deleted "sustained"

P10 L 19: "...all subglacial lakes that were identified had low hydrostatic gradients (Fig 4)."This is a very powerful argument supporting the presence of subglacial water, but Figure 4doesn't really allow us to evaluate the hydraulic gradient of most of the lakes… This doesn't necessarily need any addition to the figure, a simple statement like "X% of the lakes had a hydraulic gradient less than Y" would suffice.

Added to the <u>Results</u> section under <u>Additional subglacial lakes:</u> "*50% of segments of specular bed that were 1 km or greater in length had hydraulic head*

gradients less than 0.1%, meeting the criteria for a lake in Carter et al., 2007, and 71% were less than 0.2%. This result is consistent with flexural support of small gradients around the edges of these small lakes (Carter et al., 2007)."

P 14 L 2-4: "Small scale roughness, at length scales of the line spacing and below, is relevant for three reasons: 1) roughness gives insight into the pathways that basal ice must traverse; 2) roughness may provide information on past ice sheet behavior and basal conditions and 3) roughness is a key control on the uncertainties inherent in profiling radar systems."

I would add a fourth factor: 4) basal roughness forces the overriding ice sheet to develop a complex deformation field in the lower part of the ice column, and this deformation field could disturb stratigraphic continuity of the ice core record.

> **Added suggested text**

P 16 L12 "...will not be available for melting on the intervalley regions." "Peaks". The word for "intervalley regions" is "peaks".

> **As peaks suggests a sharp edge, and many of the "intervalley regions" are flat, reworded as follows: "...*for melting on the highs between valleys.*"**

P16 L17: "...observed driven stresses..." Should be "driving stresses".

> **Done**

P17 L17-18: "However, a trade-off is that maintaining a simple flow path for basal ice in such a rough environment will be difficult, and the mountainous region also induces relatively large driving stresses in the overlying ice."… I would recommend adding a sentence here about the importance of accumulated deformation along the flow path of the basal ice.

> **Added** *"The paths taken by basal ice elements in such an environment may be torturous, and result in stratigraphic complexity."*

P18 L27: "The result is that the first return will tend toward the minimum ice thickness within the beam pattern, however the measured thickness at this site will be slightly overestimated." … I would recommend rephrasing this sentence as, "The result is that the first return will tend toward the minimum ice thickness within the beam pattern, and the measured thickness at this site will be systematically underestimated relative to the true nadir thickness."

As I wish to force the reader to think both in terms of horizontal as well as vertical uncertainty, I reword as follows:

"The result is that the first return will tend toward the minimum ice thickness within the aircraft beam pattern, however the measured thickness at the site of reflection will be slightly overestimated. The primary uncertainty will be in the cross-track position of the bed echo. Alternatively, if it is assumed that the echo is from nadir, the inferred ice thickness will tend to be underestimated."

Supplementary Material:

I was not able to locate a table describing the subglacial lakes in the supplementary material. A table listing the centroid lat/lon, mean ice thickness, and along-track length (plus any other variables the authors think are relevant) for each lake should be provided. This table could also be placed in the main text or appendix instead of the supplementary material, as there are only 40 new lakes.

A csv file is now included with the requested parameters, as part of generating this file new lakes were found, changing in the numbers (but not the conclusions) in the results section. as the number of lakes has increased to 54, I have elected not to put them in the main text.

Figures:
Fig 2: Move the label for Candidate A from the right side of the candidate to the left side.

Done

In the current configuration it looks like the label refers to the yellow box. The statement "Regions of disagreement between Bedmap2 and other dataset is shown by the yellow boxes in all panels" is confusing. After reading the text, it is clear that what you are referring to is a misalignment between trends in the surface slope field and trends in the bedrock topography. Clarify this in the caption.

Reworded to: "Regions where trends seen in surface data are absent in Bedmap2 are shown by the yellow boxes in all panels."

Fig 3: The caption states that the color scale is relative power after geometric correction. I interpret this to mean that the effects of geometric spreading on echo strength have been removed. However, the shallow layers are still much brighter than the deep layers. Is this because of attenuation, or is my interpretation of this sentence incorrect? If the whole echogram has been geometrically corrected, I would also expect the noise floor near the bed the bed to feature a color ramp, with brighter speckle below and dimmer speckle above, rather than a uniform black.

At these ranges, the geometric loss term near the bed is less than a 2 dB per km, limiting any color ramp near the bed. I quantified the layer brightness and layers at 1000 meters depth are within 5 dB of layers at 2000 m. Part of the apparent brightness may be due to surface scattering; therefore I add:

"Near surface layers have superposed surface scattering."

Fig 5:
There is a problem with the bed elevation and RMS deviation colorbars. Both of them have rendered with a color gradient across the colorbar in addition to the intended color gradient along the colorbar. The label for the RMS deviation colorbar would be more instructive if it simply said, "Bed Roughness (m)". The caption can clarify that roughness is defined as the RMS deviation of the bed within an 800 m rolling window.

Done

Fig 6:

This colorbar has the same issue as those in Figure 5.

Done

Fig 8:

The x-axis should have the more straightforward and descriptive label, "Roughness", with the definition of roughness (RMS deviation within 800 m window) in parentheses. As written it reads as if the units are multiples of 800 m.

Done - plots were replotted with slightly different data