Review: Ross et al., Review Article: The Foundation-Patuxent-Academy ice stream system, Antarctica (Manuscript #: egusphere-2025-3625)

We thank the reviewers for their careful and constructive assessments of the manuscript. Detailed responses to specific reviewer comments (highlighted in grey) are provided below (non-highlighted italic text). Line numbers in this response document refer to the marked-up copy of the manuscript.

REVIEWER 1

Review of Ross et al., 2025 (doi:10.5194/egusphere-2025-3625)

"Review Article: The Foundation-Patuxent-Academy ice stream system, Antarctica"

Overview:

This review paper is a call to arms to focus on the sprawling Foundation-Patuxent-Academy System, a collection of ice stream catchments that flow from Dome A into the intersection of the Filchner and Ronne Ice Shelves. In general, it is a fine and timely overview, but there are gaps, and places where things could be clearer. There are elements of a proposal in here, so forgive me if I approach it with that mindset.

We are grateful for Reviewer 1's positive comments about the manuscript. We appreciated their suggestions for gaps to fill and their guidance on where to make the manuscript clearer. We have applied these changes in most instances. We do have one eye on future research with this review article, but it was not the primary reason for us writing it. We are however pleased that Reviewer 1 has identified "elements of a proposal" within it.

Major issues:

Section 1:

It appears a key point this paper is trying to make is a shift from an ice shelf oriented view to a grounded ice point of view of the system (the historical priority of the ice shelf is a natural outcome of the evolution in satellite remote sensing described in the discussion of Section 3 below). Authors could be more explicit in why they want to make this contrast.

To address this comment and to emphasise the focus of the review manuscript, we have added the following text to the final paragraph of section 1 (introduction) (lines 63-66):

*"*Here, we focus on the grounded parts of the FPAS. Much recent Antarctic glaciological research, including in the Weddell Sea sector, has focused on ice-ocean interactions and the potential impacts of ocean warming (e.g. Davis et al., 2023; Hill et al., 2024). However, here we pivot the focus to the grounded ice inland of FRIS with the aim of highlighting how factors other than ice-ocean interactions can potentially drive glaciological change of the FPAS.*"*

Figure 1 is not clear. The forest of overlapping red boxes with letter pointers to numeric pointers to other figures does not add much value. You could combine a simple insert map of all Antarctica, showing simply the major subcatchments you describe here, with Figure 10 (the block diagram), and it would be clearer what you are talking about. There is talk of flux gates which are not shown.

We agree with Reviewer 1, and have updated Figure 1 removing all but one red box, which shows the extent of 1b-d. We have removed the reference to fluxgates in the figure caption, and the annotation on the figure, as the FPAS fluxgate was not easily shown at the scale of the figure. The "forest of overlapping red boxes" has been replaced with inset location maps in figures 3, 4, 5, 6, 7 and 9. To make figure 1 clearer, the size of the subplots has been altered, and content has been moved between subplots (e.g. 1a and 1b). As a result, the figure caption has been extensively updated (see marked up copy of manuscript).

Section 2:

The numbered 'insights' (eg "Bed geometry near the grounding zone" here are titled as generic targets. I think those targets could be phrased as actual insights. Why do we care about the bed geometry near the grounding zone? etc etc. Frame them as a provocation. A pithier version of the first sentence of each section. Alternatively, you could refer to them as 'targets of investigation' instead of 'insights'.

We have adopted the suggestion to refer to the numbered 'insights' as 'targets of investigation'. We have retained reference to 'insights' in Line 90 but have made the alteration in line 98 so that it now reads: "These have enabled the identification of five targets of investigation for the FPAS, which provide justification for this review and for future research:"

Section 3:

There is a good historical section that goes into the detail of the early exploration of this issue. However, it is missing a discussion an element that has profoundly shaped the understanding of this region - the remote sensing 'pole hole' that meant we didn't have good topography of much of this region before IceSat-1 in 2003 (DiMarzio et al., 2003), which was significantly, but not totally advanced by Cryosat-2 in 2014 (Helm et al., 2014), and then it wasn't until TanDEM-X (Wessel et al., 2021) that we managed to fill in the key intersection between Foundation and Academy (and event then there are issues with the accessibility of that dataset).

We have introduced text to the end of section 3 (lines 239-243) of the revised manuscript to describe the 'pole hole' and its influence on FPAS research. We appreciate the useful suggestions for literature to include. The new text is:

"Historically, an important gap in our knowledge of the FPAS was the poor constraint on ice surface topography and ice velocity from remote sensing. The ice surface topography 'pole hole', was partly filled by ICESat and CryoSat-2 observations (Shuman et al., 2005; Helm et al., 2014), but complete coverage to the South Pole (Fig. 1c), and therefore the key intersections between the glaciological components of FPAS, was only completed by the TanDEM-X digital elevation model (Wessel et al., 2021)."

Surface velocity is a similar story: image based velocity tracking (Gardner et al., 2019) - the only data we have for much of the system is from Radarsat-2 coverage from ~ 2015 (Mouginot et al 2019), with significant errors in key parts of the onset of this system. NiSAR should address a lot of the surface velocity issues. The role of intuition on this system from balance velocities derived from incomplete surface topography data is a key part of the story (which was acknowledged as an issue at the time (eg Bingham et al. 2007)).

We have included additional text to address the surface velocity gap too. The challenges associated with ice velocity errors in this region was something that had become more apparent to the author team since manuscript submission of this manuscript. Because section 3 is a historical perspective, we did not make reference to NiSAR data in the revised text (although it was already mentioned in section 5.3). The revised text (lines 243-246) is:

"Prior to satellite observations of ice velocity, ice flow south of 87° was derived from balance velocities calculated from ice surface topography, ice thickness and surface accumulation datasets (Bingham et al., 2007). Though we now have remotely sensed observations of ice flow to 90°S (Fig. 1a), they are limited to the RADARSAT-2 derived product which has relatively high errors in the onset zones of the FPAS (e.g. Academy Glacier) (Mouginot, et al., 2019)."

On the airborne geophysics side, it's probably worth mentioning the SOAR/Pensacola-Pole Transect (Studinger et al., 2006, Holt et al., 1998, Blankenship et al., 2025) which first traversed this system at the South Pole.

The absence of references from the SOAR/Pensacola-Pole Transect (PPT) was an oversight. We have inserted references related to this survey (Studinger et al., 2006 and Carter et al., 2007) into Line 228.

Carter, S. P., Blankenship, D. D., Peters, M. E., Young, D. A., Holt, J. W., and Morse, D. L.: Radar-based subglacial lake classification in Antarctica, Geochem. Geophys. Geosyst., 8, Q03016, https://doi.org/10.1029/2006GC001408, 2007.

Studinger, M., Bell, R. E., Fitzgerald, P. G., and Buck, W. R.: Crustal architecture of the Transantarctic Mountains between the Scott and Reedy Glacier region and South Pole from aerogeophysical data, Earth Planet. Sci. Lett., 250, 182–199, https://doi.org/10.1016/j.epsl.2006.07.035, 2006.

The value of Figure 3 is not clear, especially panels c-e. It might be clearer just to show the various bedmaps (including bedmap1) to show synoptic scale changing in configuration. To make the point about poorly optimized collection, maybe using the ILCI figure (Fig 6 in Bingham, Bodart, Cavitte, Chung, Sanderson and Sutter et al., in press) might make the point better.

Having reflected on comments from both reviewers on figure 3, we decided to remove subplots c & e. However, we retained d (now c) & f (now d) as we wanted to demonstrate the substantive differences that exist between Bedmap3 and BedMachine v3. This is despite these data products using similar (if not identical) input data across FPAS. Subplots a-b were retained as they demonstrate how poorly sampled some parts of FPAS are, as well as the high bed topography uncertainty in Bedmap3 that results from this sampling. A location inset was also added to reduce clutter on figure 1. Changes to figure 3, particularly the removal of Bedmap2 information, have led to knock-on adjustments to text (see lines 229-234).

Lastly, there now has been an very extensive recent survey of the onset region of this system through NSF COLDEX; data has been out for a while (Young, Paden et al., 2024), and now actually a paper (Young et al., 2025), which has implications for how this

system is initiating (obviously this came out after the paper was submitted, but is relevant to this review paper).

We were aware of a few COLDEX papers that were available as preprints at the time we submitted our review but thought it wise to wait until they had been published to include. We have added reference to Young et al., 2025 in the list of references citing post 1990s surveys in section 3 (line 229), and at other appropriate locations in the manuscript (line 617). However, to avoid reworking topography datasets in the figures – which are currently based on Bedmap3 that does not include COLDEX data - we have not deployed the COLDEX data in the manuscript.

Section 4:

This section starts with two paragraphs which are a half page long, which makes it a little hard to parse. Names are introduced that are not in the Antarctic Gazette (eg "Foundation Trough") - the authors should make it clear what is official and what is not, and maybe consider a plan for getting them approved if not.

We have split the first paragraph of section 4 into two (new paragraph at line 261), and the second paragraph into three (new paragraph at lines 292 & 299).

To make it clear that the term "Foundation Trough" is not an official name, we have inserted "- an informal unofficial name for this valley -" into the opening sentence of section 4 (line 249), so that it now reads "The ~52 km-wide Foundation Trough - an informal unofficial name for this valley - underlies the FPAS trunk".

We note that 'Foundation Trough' (or 'Foundation-Thiel Trough') has been in informal usage for some time, having been referred to in previously published papers (e.g. https://doi.org/10.1016/j.quascirev.2016.09.028 & https://doi.org/10.1029/2018GL077504). As the Foundation Trough is within the geographic remit of the UK Antarctic Place-names Committee, we can liaise with that committee about formal approval.

The discussion of Joughin et al 2006 in the context of in Academy roughness is a little indirect, since that paper does not explicitly mention Academy Ice Stream or roughness. It does seem that what Joughin's inversion is picking up is the prominent cross flow ridges visible in MOA imagery, which the FISS and Polargap survey lines in Figure 4 are not well oriented to detect (which does go to the authors' point on coverage in Section 3).

Joughin et al. (2006) envelope the entirety of FPAS into a single 'Foundation Ice Stream' catchment and therefore do not mention Academy Glacier directly (see their Fig. 1). However, Joughin et al's Figures 2, 3 and 6, and Section 'e' do show and describe all the major FPAS components (Foundation, Patuxent and Academy).

We agree that Joughin's inversion probably picks up the prominent cross flow ridges visible in MOA imagery. However, we have not made this link in the manuscript.

Reviewer 1 is correct that Joughin's inversion does not mention roughness, and in response we have reworded lines 262-264, to remove direct reference to "roughness". It now reads: "Inverse modelling of ice flow velocities, using BEDMAP (Lythe and Vaughan, 2001), had previously suggested that the rough topography (implied by high values of

basal shear stress) beneath Academy Glacier might continue 200 km further inland (Joughin et al., 2006).”

On the roughness trend inland - at least with the color map in Figure 4a, it's still looking fairly smooth on the rebounded bed >0 elevation topography.

We acknowledge that the roughness deep into the Pensacola-Pole Basin (i.e. proximal to South Pole) is still relatively smooth. However, there are clearly (relatively) abrupt lateral contrasts in roughness around Patuxent Ice Stream and the mid-parts of Academy Glacier that warrant further (future) investigation. We thought it was important to highlight: (i) these ‘contrasts’ in the review - as to the best of our knowledge this pattern of roughness has not been shown previously, and (ii) the apparent spatial coincidence with the topography below the 0 m rebounded contour in many areas of FPAS. We have removed a reference to “significantly” lower roughness (Line 265) and have inserted three references to “relatively” low roughness in lines 266, 287 & 292. These minor changes to wording hopefully address Reviewer 1’s comments here.

Figure 4. Using consistent colours between panels a and b for the bed contours will make it easier to compare. For FAIR purposes, include the granule/flight information for the radargram in the caption.

The 0 m contour is now consistent (grey line) across panels a and b. The radar transect flight name (POLARGAP_P13A) has been added to the figure caption. Additional minor formatting changes have also been made to figure 4 (see caption), including the addition of an inset location map.

Figure 6 has some issues. In a) The higher discharge values are hard to distinguish from the background color map. In the legend the text Subglacial Lakes bleeds directly into Channel Discharge. 6a also needs a scalebar.

We made the following changes to figure 6a:

- *Background hydropotential map colour changed to distinguish it from the higher discharge values.*
- *Legend edited so that the ‘subglacial lakes’ and ‘channel discharge’ text no longer bleeds into one another.*
- *Scalebar moved outside the legend to make it more visible.*

6b (directly taken from Siegfried and Fricker, 2021) should be located on 6a, not on a separate figure on a separate page. The box for 6d should be shown on 6a, or the catchment boundaries should be added to 6d for reference.

We have removed figures 6b-d from figure 6 as we no longer feel that they are essential figures for the manuscript. No change required.

The Jordan 2018 downdraw is shown on Figure 5, but not fully discussed in the text until after the subglacial hydrology section - I would suggest adding it to the subglacial hydrology figures. Would it be possible to add the Jordan flow routes (yellow line their Fig 3) to these figures?

We have added the extent of the downdraw zone to figure 6 (formerly figure 6a). However, the more limited extent of figure 7 precludes its inclusion there.

We have not included the Jordan hydropotential flow routes (or a more updated version of this analysis) on Figure 6. This is because of the assumptions (e.g. warm bed throughout) and uncertainties (e.g. in bed topography etc.) associated with that type of analysis. Instead, we have retained the hydropotential contours currently included in Fig. 6a. These indicate the broad potential pattern of basal water flow (i.e. from high to low pressure), rather than potentially unrealistic details. The model output from Ehrenfeucht et al., 2025 in 6 and 7b is a better estimate of where water is present at the FPAS bed than a simple Shreve-type analysis because it accounts for basal thermal temperature.

line 426: It's not clear that the dynamic summit migration seen at Dome C, which is solely a function of velocity, would have any direct bearing on ice sheet geometry.

The inclusion of this information and reference was to demonstrate that ice sheet interior geometries are not static and can change at quite rapid rates. However, we have deleted the following sentence and the associated reference:

"Observed rates of modern-day dynamic summit migration at Dome C are in the order of 100 m a-1 (Vittuari et al., 2025)."

Vittuari, L., Zanutta, A., Gandolfi, S., Martelli, L., Ritz, C., Urbini, S., and Frezzotti, M.: Decadal migration of Dome C inferred by Global Navigation Satellite System measurements, J. Glaciol,1-48, https://doi.org/10.1017/jog.2025.28, 2025.

The Hydrogeology section could use some paragraph breaks.

We have split the hydrogeology section of section 4.2 into 3 paragraphs at lines 479 & 487.

Section 5:

It seems there is a missed opportunity to directly tie the targeted activities in Section 5 to the insights in Section 2.

In an earlier draft of the manuscript, we did link the insights (now "targets of investigation") in section 2 to section 5. However, this: (1) resulted in a series of very similar 'lists' repeated throughout the manuscript; and (2) did not facilitate a flowing section 5 where several of the subsections overlap the 'targets of investigation'/'insights' listed in section 2. To address the Reviewer's comment however, we have modified lines 641-642 to state "These priorities, broadly based on the 'targets of investigation' outlined in Section 2, are organised within three overarching research headings:……."

Figure 9: Put titles of panels on the panels.

This is a helpful suggestion from reviewer 1, as it helps readers distil the information in the figure more readily. We have actioned this with shortened versions of the figure caption titles. We have also added an inset map to show the extent of the subplots in figure 9.

line 678: "For example, some reported 'Academy Glacier' active subglacial lakes (i.e. A14 and A16) could be located beneath Support Force Glacier instead. " This does not make sense as written. You have defined the margins of these features in this paper, and the locations of the active lakes is well determined. Are you suggesting that there are

Academy Glacier and Support Force Glacier hydrological catchments that do not correspond to the ice declared ones?

There is considerable complexity in accurately defining the boundaries between the ice flow and hydrological catchments of Academy Glacier and Support Force Glacier. This is because of uncertainties in the ice velocity and ice thickness/bed topography datasets, as well as errors that propagate into derived products such as hydrological flowpaths etc. When the active lakes were categorised in the late 2000s, that uncertainty was even greater because of the datasets available at the time, so that some of the active lakes designated as 'Academy' lakes at that time now appear to be beneath ice within the Support Force Glacier ice flow catchment. This can be seen in figure 7b, where A14 and A16 are either below (A14), or to the (geographic) north east (A16) of the IMBIE ice-catchment boundary between Academy and Support Force Glacier. Of course, which 'side of the line' these potential active lakes reside on is highly dependent on the accuracy of the defined mass balance catchments, which is why we originally opted for a conservatively worded sentence.

To address Reviewer 1's comment, we have edited lines 420-424 so that they now read:

"Several of the current active subglacial lakes (i.e. Academy lakes 12-16, Fig. 7) are located at or near the boundary between Academy and Support Force glaciers. Based on the ice flow defined mass balance catchments (Fig. 7b), some lakes classified as belonging to Academy Glacier (i.e. Academy 14 and Academy 16) could be part or entirely located beneath Support Force Glacier (Fig. 7). Water piracy could result in lakes at or near the Academy-Support Force boundary switching subglacial hydrological catchments."

Minor issues:

In general - more paragraph breaks.

We added more paragraph breaks in multiple locations in response to specific comments and suggestions from both reviewers.

Also for radargrams add more granularity to the reference - allow readers to go directly to the Polar Airborne Geophysics Data Portal or equivalent and look at the same radargram at full resolution.

We have added radargram transect names to the captions of figures 2 and 4. Readers can then use this information to access the radar data on relevant data portals if they wish to do so.

line 366: sub-iice -> sub-ice

Amended (line 403).

line 373: "Based on overburden hydraulic potential calculations, but not model results (Dow et al.,2022)," Awkwardly phrased - does Dow and GLADS imply that water-route switching is unlikely?

Yes, the model output from Dow et al. does not support the idea of water-route switching. We have edited the sentence (line 410*) to remove reference to the model runs, and inserted the following text later in the paragraph (lines* 415-417*): "We note that*

water routing switching was not an outcome of numerical modelling experiments (Dow et al., 2022), although such scenarios were not explored explicitly in the model set-up."

line 696: "Aurora Basin" -> "Aurora Subglacial Basin"

We have amended this (Line 779).

REVIEWER 2

The questions listed above do not fit well with a review paper. The paper is fine, an excellent review of the literature and most of the aspects of importance to this part of Antarctica. But as a review paper of the state of knowledge, how can it be, e.g., 'excellent' in (1) originality? or (3), 'changing our scientific understanding of a subject'? Editors may with to reconsider the questions for a paper of this type.

We are very appreciative of the positive comments from reviewer 2 about the manuscript here. Thank you. We will leave the issues with the questions listed to the TC editorial team.

Review of Ross et al. The Cryosphere -
Review Article: The Foundation-Patuxent-Academy ice stream system, Antarctica

The paper presents an overview of the observations and some of the potential processes of this multi-channel ice-stream system, with a strong focus on the bedrock geometry and potential for marine ice sheet instability processes to take hold in the century-scale future.

There are numerous comments in the attached .pdf mark-up.

We have extracted those comments from the marked-up PDF and included them at the bottom of this response.

This is well-written, not hard to follow, and fairly thorough for the aspects that are covered. It could be published as it is, but as it is, it will fall a bit short of stimulating the kind of community push to work in the area that it seems to be calling for.

We appreciate the positive comments about our review paper here, and that it "could be published as it is". We are keen to stimulate a community push to work in the FPAS and surrounding region so have carefully considered the suggestions to develop the manuscript for this purpose.

The top comment is that much more should be said, from the beginning, about the ocean side of the story and the potential for warm deep water to enter the Filchner-Ronne cavity and cause retreat along the entire grounding zone discussed here (and the Institute-Möller too). I wasn't sure this had been expanded upon since Hellmer et al., 2012's work, but I see that several papers, and not just from Hellmer, have discussed this possibility more recently. This should be the main driver of a push to understand the system now, and model how it might behave in the 22nd – 23rd century.

We were wary of pinning the justification for the manuscript on Hellmer et al., (2012) because it is likely a high-impact, low-likelihood end-member scenario. Because of the location and configuration of the FPAS grounding zone, it would likely take a long time for changes in cavity circulation to propagate to it from the Filchner Ice Shelf edge. We therefore took a cautious approach in our justification for why FPAS is important, avoiding possibly unrealistic 'alarmist' statements for this part of the Antarctic Ice Sheet, where glaciological change on the scale of the Amundsen Sea Sector is not currently occurring. We were also keen – as reviewer 1 identified – to pivot the research in this area towards the grounded ice, rather than the ice shelf.

However, as suggested by reviewer 2 (see comment below associated with ~Line 78), we have added a sentence on the potential impacts of a warmer ice shelf cavity on the FPAS into section 1 (lines 46-49). This reads:
"Though currently in equilibrium, this could change under a future scenario where warm circumpolar water inflows through the Filchner Trough to the southern grounding zones of FRIS (Hellmer et al., 2012), and the FPAS and adjacent ice streams respond through grounding line retreat and changes to ice flow (Naughten et al, 2021; Hill et al., 2024)."

In addition, we have inserted the following text into section 4.4 (lines 604-607):
"The potential for the FRIS cavity to shift from a cold to warm regime, driven by the inflow of warm circumpolar ocean waters on the continental shelf (Hellmer et al., 2012), may also drive glaciological change to adjacent ice streams (Hill et al., 2024), with uncertain implications for the FPAS."

Given that: (1) the ocean is inherently part of the major forcing for potential future sea level rise from the region; and (2) that one of the future research directions in section 5.3 (number 4) is "observations of ice-ocean-hydrology interactions" we hope that these additional sentences earlier in the manuscript provide the necessary context as to why ice-ocean interactions are important. We have adopted this approach so that we avoided diluting the primary focus of the current manuscript - the grounded parts of the FPAS catchment - and to ensure that additional ice shelf-cavity content didn't further widen the scope of the manuscript (e.g. encroaching into discussing other large Weddell Sea Sector ice streams that flow into the Filchner Trough).

A second high-level comment is that the paper might consider including the Support Force Glacier as well, since there are several strong links at the regional scale between the areas discussed and SFG. This would entail a significant re-write, but really, most of the data sets and figures already include this area, and the strong likelihood of water piracy and ice flow re-direction make it logical to include it (e.g., Figure 7).

We chose not to add substantive additional Support Force Glacier content to the review (e.g. including it in the title of the manuscript, detailing its glaciological setting, how it flows etc.) as it is a separate system to FPAS (e.g. it has a separate flux gate). The original submission already recognised the importance of Support Force Glacier to FPAS, how the two systems interact, and explained how they are distinct. Support Force is referred to multiple times across several sections of the manuscript (e.g. sections 2, 4.1, 4.2 and

5.3); and there is a clear statement in section 1 about Support Force being distinct and separate (i.e. "Here, we retain a distinction between the FPAS and the adjacent, but separate, Support Force Glacier, which adjoins upper Academy Glacier (Fig. 1) yet has a distinct catchment and flux gate.").

Following the suggestion of reviewer 2 however, we have added additional specific references to Support Force in the abstract, and added the following sentence to the 'basin location' part of section 2 (lines 143-145): "Geographically, the greatest potential for dynamical interaction with other catchments appears to be with Support Force Glacier, which has a poorly defined, and ice flow parallel boundary, with Academy Glacier (Fig. 1)."

At the end of the paper (Section 5 and sub-sections, Figure 10), the authors list what is not known about the system, and what might be done. The items listed are indeed not well-known, but a similar case could be made for virtually any large ice stream system in Antarctica --- the posed questions are not drivers for research in this area. The points made are valid, but they are broad, geographically wide-ranging, and not focused into a logistically efficient and fundable set of objectives.

We acknowledge the point made by Reviewer 2 here, but we feel that that the items listed in section 5 and subsections are sufficiently FPAS (&Support Force)-specific. The manuscript is not intended, nor designed, to provide "a logistically efficient and fundable set of objectives". Instead, it is intended as a broad inspiration for future, more specific, funding proposals in this region. The focused, logistically efficient and fundable set of objectives is a later (i.e. post review paper) step in the development of future FPAS (& potentially Support Force) research. We have therefore not made substantive changes to the manuscript in response to this comment from Reviewer 2, but have inserted some additional specific references to "FPAS" within section 5 (e.g. line 681).

As noted, the paper could be published more or less as it is. It's not wrong, it has a comprehensive bibliography (but missing ocean conditions and circulation in the Filchner-Ronne cavity);

But if the goal is to motivate a major research program, for example, for the upcoming International Polar Year 2032-2033, then I would suggest the following;
Include the possibility of a large increase in ocean-driven melting as per Hellmer and other papers; this is probably an additional section discussing the oceanography of the Weddell generally, and the drivers that might lead to warm-water intrusion into the Filchner cavity;

We are delighted to hear that Reviewer 2 believes that "the paper could be published more or less as it is" and that the reviewer reinforces that point again here.
As stated in an earlier response to Reviewer 2, we have inserted sentences to sections 1 and 4.4 about the potential for ocean-driven melting and have included the Hellmer et al., 2012 reference. However, because it would pivot the manuscript away from the 'grounded ice' focus identified by reviewer 1, and will further extend an already long manuscript, we have chosen not to add a substantive section or sections to the

manuscript on the oceanography of the Weddell Sea, and the drivers that might lead to warm-water intrusion into the Filchner cavity, as it would be beyond the scope of the current manuscript.

Shorten Section 5 to be a concise general setting out of the regional questions (adding ocean and sub-shelf cavity ones). I would add in Support Force, since both the basal topography, hydrology, and surface flow are all potentially connected, in the past or in the future.

We have edited the section 5.2 heading to read: "How does the FPAS interact with Support Force Glacier?" This is associated with edits to the text of section 5.2 (see lines 699-759 of the marked up manuscript) to amplify the importance of Support Force Glacier, and to make section 5 a little more concise.

Create a new Section and describe an efficient, integrated research program – ocean cruises here, two logistical camps here and here, with the key science questions addressed by this and that set of observations located in these selected locations, reachable from the camps; point out how the key locations you have identified for camps and for measurments are the best ones to address the questions; describe the goals and data sets of a continuing remote sensing effort; and describe how, e.g., new airborne data and the field data might feed into new modelling by the skills represented in the author list. Talk about the high potential for a UK-European-US collaboration.

We have not included a new 'Section 6' describing "an efficient, integrated research program….". This is because: (i) the manuscript is a review paper, not a proposal – it is not a manuscript that pre-empts a large special research programme akin to ITGC; (ii) the FPAS community is not yet at the stage of research development where we can provide these level of details; (iii) at this point in time, we do not necessarily envisage a full ITGC-style programme to undertake future FPAS/SFG research; and (iv) we feel that there are ethical/research governance issues relating to us delivering the requested level of detail at this stage (i.e. when proposals are not yet initiated).

We note that reviewer 2 has twice stated above that the manuscript "could be published as it is" hence why we suggest that the creation of a new section 6 is unnecessary. Such information is appropriate for future research proposals, but not for inclusion within this review article.

But don't make the mistakes ITGC did: be efficient, stay within the logistical realities; keep the field teams a bit smaller, UK-style, and have a phased field work plan that doesn't overwhelm the capabilities in any given year. Don't get me wrong – ITGC is a magnificent accomplishment, but it could have been easier to accomplish.

This is helpful guidance and input from reviewer 2 and will be a useful steer for any future (potential) science on FPAS. Thank you.

Specific comments from PDF

Title: As I note later, consider adding the Support Force Glacier to the review. The manuscript already dwells on it quite a bit, and the high possibility of water piracy links the systems.

Please see response to reviewer 2's general comments on Support Force Glacier above.

L25: This sentence isn't necessary -- a small justification for the paper, yes, but really everything in science can claim a need for further study.

We have deleted the sentence from the abstract, but have retained "draining both East and West Antarctica". This has been incorporated into the opening sentence of the abstract, which now reads: "The Foundation-Patuxent-Academy system (FPAS) is a major Antarctic ice stream system, draining both East and West Antarctica, with a global sea level potential of ~3 m." (lines 24-25)

L26: just noting -- this list of vulnerabilities mixes those that might have a big impact on net ice flux and sea level with those that are just dynamically interesting but don't pose the same level of threat.

Yes, we acknowledge this and think that this is philosophically a good approach, for both FPAS and for Glaciology/Antarctic Science in general. We should ensure that we investigate both 'threats' and aspects of the ice sheet that are 'just dynamically interesting'. We don't know when the latter might become the former (or vice-versa!). No change made.

L35: seems like this last point is different from the others, and not needed. Uncertainties result from fewer available model runs... doesn't seem logical somehow. I'd just drop the last point.

*We'd prefer to retain this point if we can, as it (i.e. "*a shortage of FPAS-specific modelling experiments*" reflects content later within the review article (i.e. section 4.4). No change made.*

L78: A major driver for increased interest in this area (and for your earlier Institute-Möller I.S. review) is the model result by Hellmer, 2012 and related follow-on papers indicating the possibility of warm water intruding the Filchner - Ronne cavity in the 22nd century. This shoudl lead off your justifications.

In response to a general comment from Reviewer 2 we have inserted the following text into section 1 (Introduction) (lines 46-49): "Though currently in equilibrium, this could change under a future scenario where warm circumpolar water inflows through the Filchner Trough to the southern grounding zones of FRIS (Hellmer et al., 2012), and the FPAS and adjacent ice streams respond through grounding line retreat and changes to ice flow (Naughten et al, 2021; Hill et al., 2024)."

L86: start new para here

We have not implanted this recommendation as it did not seem to be a natural break between the paragraphs.

L88: maybe make these italicized headings rather than the (i), (ii) listings -- a bit over-used here?

We have deleted the 'i-v' listing here, and italicized the headings (lines 100, 116, 128, 141,151).

L100: ...all linked to the presence / absence of warm deep water in the cavity -- ?

We have amended the sentence (lines 112-115) to: "However, other modelling experiments of near-future change over shorter time periods, some of which explore the impacts of warm deep ocean water entering the FRIS cavity (e.g. Seroussi et al., 2020, 2024; Hill et al., 2024) show more limited grounding-zone retreat."

L105: break sentence in two here.

Implemented (lines 117-119). Now reads: "This makes the grounding zone highly dynamic and sensitive to changes in ice thickness. Under this geometry, moderate ice thinning would translate into significant grounding-zone retreat....."

L109: nesting of the i, ii organization style - can't do that.

This issue has been addressed by shifting to italicized headings as suggested for line 88.

L113: Cite Walker, 2013 et al here

We have inserted Walker et al, 2013 here. Now reads: "(ii) a 'bellowing' effect, as the lightly grounded ice moves vertically on tidal cycles, stirring the cavity waters and increasing melt (Walker et al., 2013);"

Figure 2: this might be better presented as two figures, or a large single figure -- in particular, the radar profiles deserve more space and perhaps more interpretive annotation. Consider a layout of (a) as a full width map (or nearly full-width), (f-i) below right, and (b-e) arranged more in a rectangular overall shape below left.

Figure 2 has been modified to give all components more space. (a) is now a full width map. The radargrams (b-e) have been moved below right. The topographic profiles (f-I) have been moved below left.

Figure 3: this seems like a lot of space for a review of improvements relative to older data. Could (a) and (b) be combined? Then perhaps just keep (d) and (f). Then perhaps a fourth panel could be the current best topography, which I think is Bedmachine v3. I think this would support your three points (i,ii,iii).

Reviewer 1 also made comments on Figure 3. Having reflected on comments from both reviewers, we decided to remove subplots c & e. However, we retained d (now c) & f (now d) as we wanted to demonstrate the substantive differences that exist between Bedmap3 and BedMachine v3. This is despite these data products using similar (if not identical) input data across FPAS. Subplots a-b were retained as they demonstrate how poorly sampled some parts of FPAS are, as well as the high bed topography uncertainty in Bedmap 3 that results from this sampling. We did not implement the suggestion of reviewer 2 to combine a&b as it would have made the combined single subplot very complex. We did not include Bedmachine v3 bed topography here as we deployed Bedmap3 throughout the manuscript (e.g. Figures 1, 2 etc.). Whether Bedmachine v3 is better than Bedmap3 is open to debate, and subject to individual views on the manual modifications that were made to Bedmap3 along deep subglacial troughs. A location inset was also added to reduce clutter on figure 1.

Figure 5: add other aspects of the geology? what is the geology of the Dufek Massif, Patuxent Range, or the bounding rocks (if known) for the PolarGap Highlands?

To retain the clarity of figure 5, we have not made any changes in response to this suggestion.

L347: Start new paragraph here

We did not implement this suggestion as it would have left a single sentence paragraph immediately before.

L348: ...to refreezing at the ice base over subglacial...

Implemented. Now reads (lines 385-386) "These features have been attributed to refreezing at the ice base over subglacial lakes and other water bodies (Wolovick et al., 2013),....."

L350: start new sentence

Implemented (line 388).

L367: sp

*Typo corrected. Now reads "*These sub-glacial and sub-ice shelf channels" (line 403)

Figure 6: The color map of elevation change is featureless... is there another mapping, maybe 2018-2020 or later that shows the drainage better?

This comment refers to figure 6c which we have now removed from the manuscript.

Figure 6: add " A ---- A' " to the graph.

This comment refers to figure 6b which we have now removed from the manuscript

Figure 6: where is (d) located? can you add a surface map to this panel?

This comment refers to figure 6d which we have now removed from the manuscript.

L454: suggesting a reference for this, makes a better case for the eastern Peninsula's LGM extent: http://dx.doi.org/10.5194/tc-9-613-2015

We have inserted the additional reference (line 500) as suggested by reviewer 2.
Lavoie, C., Domack, E. W., Pettit, E. C., Scambos, T. A., Larter, R. D., Schenke, H.-W., Yoo, K. C., Gutt, J., Wellner, J., Canals, M., Anderson, J. B., and Amblas, D.: Configuration of the Northern Antarctic Peninsula Ice Sheet at LGM based on a new synthesis of seabed imagery, The Cryosphere, 9, 613–629, https://doi.org/10.5194/tc-9-613-2015, 2015.

L497: This is also a scenario for the Thwaites region - late re-advance after the Holocene optimum-ish period.

No change required.

Figure 9: change to '...under Pliocene conditions..'

We have implemented this in the figure caption for 9c (line 583-584). The sentence now reads: "Simulated ice thickness under Pliocene conditions....."

L574: New paragraph here

*We have implemented this recommendation (line 625). New paragraph starts "*Only two FPAS-specific models exist to date."

L601: Without the impetus of a potential intrusion of warm water (if the Hellmer projection is still viable) these questions pertain to nearly any region of Antarctica.

Please see the earlier response to Reviewer 2 where we argue that that the items listed in section 5 and its subsections are FPAS (& Support Force)-specific.

To address the specific comment here relating to L601 (opening paragraph of section 5.1) however, we have adapted the sentence immediately following the 'questions' at the start of section 5.1 so that it now reads (lines 656-657):
*"*Addressing these unknowns, essential for evaluating how the FPAS may respond to future climate or oceanographic driven change (e.g. Hellmer et al., 2012), requires four targeted activities:"