

P1, line 8: Replace “on” with “for” (*for* numerical ice-sheet models)

P1, line 12: Delete “in contact with the bed”.

P1, line 22: Change to “The Ross Sea Embayment (RSE) drains ~25% of the AIS into the Ross Sea and thus is the largest drainage basin in Antarctica, fed by multiple ice streams...”.

P2, line 11: Change to “Multibeam swath bathymetry provides a record of bed conditions beneath the former ice sheet, ...”.

P2, line 12: Change to “These landforms record flow behaviour and past thermal regimes of formerly grounded ice.”

P2, lines 15-16: Change to “This unique and integrated dataset ... much higher resolution, thereby revealing the palaeo-ice sheet bed with a much higher resolution compared to their modern counterparts.”

P2, lines 17-19: Change to “...this dataset to define glacial geomorphic features that characterize past flow and retreat dynamics, thus reconstruct ice-sheet paleodrainage across the Ross Sea Embayment during and subsequent to the LGM.”

P2, line 21-22: “Change to “..., which preferentially eroded along pre-existing tectonic lineaments (you may give a reference here).”

P3, line 5: Write “Austral summer”.

P3, line 16: Replace “cannibalized” with “eroded” or “obliterated”.

P3, line 24: Replace “post-LGM” with “postglacial”, since some features may be covered by sediments that started to deposit prior to the LGM.

P3, lines 24-25: Replace “(post-)LGM” with “glacial” since some of the subglacial features in the RSE do not necessarily record LGM ice cover.

Results section:

I suggest renaming section to “Results and interpretation”. Descriptions of features and references to similar, already described features elsewhere are largely missing – at least for the new dataset. Which landforms did you detect, how would you describe them, do they resemble already published features, and how do you interpret them on that basis (Description – Reference – Interpretation – Significance).

P3, lines 28-29: Change to “Subglacial landforms form beneath permanently grounded ice that exerts the offset buoyant forces by the ocean.”

P4, line 27: Replace “equivocal” with “controversial” and give reference(s) for this statement.

P5, lines 4-5: Rephrase to “Ice-marginal features form within the grounding zone, the transition from permanently grounded ice to ice that decoupled from its bed to become a floating ice shelf.”

P5, line 5: Either mark listed features as examples (e.g. GZWs, marginal moraines, ...) or list all of them.

P5, lines 11-12: Not exclusively – large GZWs may also indicate higher sediment flux.

P5, lines 13-14: Also reference Dowdeswell and Fugelli (2012), GSA Bulletin in this context.

P5, line 14: Replace “stratification is” with “reflectors are”.

P5, lines 20-21: They were also described with clearly asymmetric shapes (cf. Winkelmann et al., 2010, QSR; Klages et al., 2013, QSR).

P6, line 2: Reference Larter et al. (2012), QSR and Klages et al. (2015), Geomorphology in this context. They described and interpreted those features.

P6, line 5: Rephrase to “Their association with vertical tidal movement...”.

P6, line 17: Rephrase and avoid “propelled”.

P6, line 21: Be more specific here and write: “Shelf-edge gullies on high-latitude continental margins...” since gullies are found on most continental margins.

P7, line 8: Write “... any potentially pre-existing subglacial landforms.”

P8, line 6: Replace “monopolize” with “dominate”.

P8, lines 9-10: Not only – they mainly imply bulldozing of proglacial debris.

P8, lines 15-16: The GZWs are large but not visible in the bathymetric data? Do you mean wide but relatively thin so that they are hardly visible in the bathymetry? Specify here.

The same applies for lines 25-27.

P8, lines 29-30: Rather write something like: “Phases of different flow directions in the ERS can clearly be identified by the presence of multiple generations of overprinting linear features.”

P9, line 2: Replace “ensure” with “proof”.

P9, line 3: Rephrase to “... each flowset only slightly deviate by less than 10°, thus are assumed to represent...”.

P9, line 4: Replace “isochronously” with “simultaneously” or “contemporaneously”.

P9, line 5: Delete “after” and replace with “cf.”.

P9, line 5-7: Modify sentence to “Assuming that all flowsets were shaped during and subsequent to the LGM, a relative chronology of their formation can be assessed based on their landward succession and cross-cutting relationships with other flowsets”.

P9, lines 7-8: Modify sentence to “In order to characterize large-scale regional flow patterns, discrete flowsets within the 10° deviation are assumed to reflect a similar ice-flow configuration.”

P9, lines 9-10: Modify sentence to “Our new compilation of RSE bathymetric data reveals that major flow patterns in the ERS generally deviate from the trough-parallel drainage that was described previously (...).”

P9, lines 10-12: Modify to “Flow in Glomar Challenger Basin may have been only partially parallel to the trough axis. We propose that a distinct cluster of linear features indicates flow also across an inter-ice stream ridge towards Whales Deep.”

You sometimes write “Whales Deep” or “Whales Deep trough” – be consistent.

P9, line 12: Replace “curved” with curvilinear”.

P9, lines 13-15: Modify sentence to “For those, rose diagrams were used to exclude the possibility the curvature indicates two discrete flow events with very similar orientations.” P9, line 16: Replace “mirror” with “resemble”.

P9, line 17: Replace “display generally” with “record”.

P9, line 18: Write “...to the trough axis, pointing towards...”.

P9, line 20: Replace “as” with “to indicate”.

P9, lines 24-25: Rephrase to “We interpret the LGM grounding line in outer Drygalski Trough to have been situated just north of Coulman Island, marked by the outermost GZW (cf. Shipp et al., 1999).”

P9, line 26: Replace “field” with “cluster” and give reference to figure here.

P9, lines 26-27: Specify here. Recorded MSGs rather give local evidence and provenance gives regional information.

P9, line 29: Rephrase to “In JOIDES Trough, maximum ice extent is suggested to be recorded by the large-scale GZW (J1) on the mid-outer shelf (Fig. 3)”.

P9, lines 29-30: Rephrase to “We base this hypothesis primarily on the presence of an up to 8m-thick glaciomarine drape in the outer trough (Fig. 3a).

Do you have evidence for this statement (cores)? If not, phrase more carefully here.

P9, line 30 – P10, line 3: Rephrase to “The observation of LGM-age carbonates on surrounding banks (...) and the presence of LGM-age tephra layers in glaciomarine sediments on the outer shelf (...) further support this assumption.”

P10, line 3: Are you really sure? Maybe these linear features are MSGs as well but just represent an older ice advance prior to MIS2.

P10, lines 4-5: Rephrase to “The LGM limit in Pennell Trough coincides with the large-scale GZW (...), located ~120 km landward of the shelf break (Howat and Domack, 2003).

P10, lines 7-9: Rephrase to “Large-scale GZWs at the shelf break, linear features that extend across the outer shelf, and extensive shelf-edge gullies (you could cite Gales et al., 2013, Geomorphology here) indicate that grounded ice likely reached the shelf break (...).”

P10, lines 9-10: Rephrase to “Thin glaciomarine sediments occur on the outer shelf and may hint at a relatively short period of ice-free conditions.” Give reference for this statement and consider the possibility that post-LGM strata may be thin but was strongly reworked by scouring or winnowing, especially on outer shelves. This weakens your argument. Same with thick glaciomarine drapes – in some locations (e.g. Palmer Deep) they are extremely thick and people assumed that this drapes started to deposit well before the LGM but then they realized it was just of Holocene age. If you don’t have radiocarbon ages, phrase more carefully.

P10, lines 11-12: You could easily combine Figs. 3 and 5. Try to implement Fig. 3 with Fig. 5 and rephrase sentence to “Figure 3 shows ... directions based on the appearance of linear features and GZWs.”

P10, lines 15-16: Rephrase to “Bathymetric records from the WRS only revealed sparse and isolated patches of linear features that hamper meaningful interpretations of former subglacial flow behaviour and direction.”

P10, line 22: Replace “ice-marginal features” with “moraines of GZWs”.

P10, line 23: Use “seafloor” rather than “seascape” and delete “grounded”.

P10, line 28: Give reference for this statement.

P11, lines 1-2: Same here and cite for example Smith et al., 2009, Quaternary Research in this context.

P11, line 3: Replace “scattered” with “a few”.

P11, line 5: Replace “to the east and the west” with “east- and westwards”.

P11, line 6: Say “during general deglaciation”.

P11, line 6: Rather say “retreat behaviour” instead of “retreat pattern” and “dominated” rather than “dictated”.

P11, line 8: Not the GZWs and moraines back-stepped onto banks but the GL.

P11, lines 9-10: I don’t understand that. One main process of marginal moraine formation is the rain-out of debris-rich material proximal to the GL. So there is no need for flowing ice really in order to deposit a moraine. It can be a slight pushing effect but that could also origin from very slow concentric flow away from the bank. If you don’t have lineations then you cannot say that there was a flow across this bank. Also consider reading Klages et al. (2013), QSR in that context.

P11, line 12: Rather write “These findings are supported by modelling approaches that...”.

P11, line 15: Rather write “Reconstructed steps in GL retreat...”

P11, line 16: Replace “time-steps” with “phases” or “episodes” and delete “representing an interpretation of relative timing”. It’s redundant.

P11, line 20: Delete “back-stepping” and write “indicating a slowly retreating GL”. Delete “in their path”.

P11, lines 21-22: Clarify what you mean here. Why does drainage of an ice sheet nourishes an ice sheet?

P11, line 24: Rather write “unaffected by topography”.

P11, lines 26-28: Write “Linear features on the ERS seafloor are overprinted by large-scale GZWs, indicating episodes of GL retreat that was interrupted by phases of temporary stabilization”.

P11, line 29: Delete “behaviour”.

P12, line 4: Replace “entails” with “requires”.

P12, lines 6-8: Write “Trough-parallel flow was then established and ice began to retreat landward from the outer continental shelf in all ERS basins, interrupted by phases of stationary deposition of GZWs... .”

P12, lines 8-10: Write “Different generations of MSGs are preserved as the GL retreats, but we would not ... of streaming would have occurred, leaving one-directional MSGs.” Delete sentence in lines 9-10.

P12, line 14: Include “the presence of” between “on” and “large”.

P12, line 15: Replace “curve across” with “flow onto neighbouring”.

P12, lines 18-24: Write “Grounded ice retreated into Whales Deep to a mid-shelf location where it halted long enough..., before it retreated towards the inner shelf to halt again indicated by GZW e3”.

How can an ice sheet not be in contact with the bed during retreat? That is contradicting. It would be an ice shelf then. And also an ice plain just prior to floatation may still create MSGs. But an absence of subglacial landforms such as MSGs does definitely not imply the absence of grounded ice. Rephrase completely and give alternatives with sufficient references.

P12, lines 25-27: Flow and thus subglacial sediment deposition on inter-ice stream ridges has recently been described as being very low (Klages et al., 2013, QSR). Cold-based ice may characterize them that is strongly coupled to its bed. At least include this different interpretation in your discussion.

P13, line 1: Delete “each”, replace “sequence” with “succession” and write “...of events that could be tested if a greater coverage of ...Basin would be available. It could illuminate cross-cutting ... flowsets that are crucial”

P13, lines 3-6: Write “Additional multibeam bathymetric surveys of inter-ice stream ridges would also provide a better understanding of the general flow pattern (cf. Klages et al., 2013, QSR). Furthermore, reliable radiocarbon ages constraining min. GL retreat on the Whales Deep inner shelf would provide the only possibility in order to give evidence for early retreat and the formation of a ‘long-lived’ grounding-line embayment.”

P13, line 10: Replace “highly” with “often” and give a few of those references.

P13, line 16: Replace “north-to-south” with “southward”.

P13, lines 22-23: Write “This study but also previous studies suggest an initial significant GL retreat within the northern Drygalski Trough are consistent ... recession of the GL”

P13, line 24: Write “...GL retreat on the remaining Ross Sea shelf (Fig. 7)....”

P13, line 25: Replace “calls for the persistence” with “suggests a persisting”. It’s actually not really clear what you try to say here. Try to rephrase.

P13, line 32: Are the ages from those publications rather ambiguous? If yes, rather delete sentence. If you keep it, you have to say why it is 'complicated' and give references for that statement.

P14, line 1: Include "geophysical" after "marine".

P14, line 16: Replace "seascape" with "seafloor".

P14, line 20: You could cite Larter et al. (2009) and Graham et al. (2009) here.

P14, lines 28-29: Which features transition into MSGs?

P14, line 31: Delete "ages and".

P15, line 1: Replace "lithification" with "consolidation".

P15, line 6: Rephrase and give reference.

P15, line 8: Delete "Complex".

P15, lines 12-15: This passage is unclear. Rephrase.

P15, lines 20-23: You need to mention also the external forcings for GL retreat here such as atmospheric, ocean, and ice characteristics. I have the feeling that this should also go into the introduction.

P15, line 26: Delete "recessional" and write "...geomorphic features that indicate episodic, ...". However, rapid and episodic are contradictory. Either specify and write that rapid retreat was interrupted by episodes of stillstand or just write "episodic retreat" (cf. Dowdeswell et al., 2008, GEOLOGY).

P15, line 28: Replace "over" with "across".

P15, line 29: Replace "indicators" with "features".

P15, line 30: Replace "was" with "has likely been".

P16, line 1: Add "shelf" behind "Ross Sea".

P16, line 1: Use inverted commas for the two model names.

P16, line 2: Replace "in the Ross Sea" with "here".

P16, line 5: Write "Ross Sea shelf".

P16, line 7: Replace "can be" with "are likely".

P16, line 8: Replace "wasn't" with "was not".

Add to the conclusions that there is a STRONG need for sediments and radiocarbon ages in order to verify or reject a lot of your hypotheses.

Tables and figures

Table 1: Since this table is very long, it could also go into the supplementary material. If you decide leaving it, please also add a column "Reference/data access", if available.

Figure 1: Indicate location of Fig. 2a. Delete the left arrow pointing away from "WAIS".

Use the northward orientation of this figure for all the following figures. Include scalebar. In the figure caption add "et al." to the Fretwell reference.

Figure 2: Use orientation from Fig. 1 for clarity. Use white font color also for "i" in Fig. 2a. Also give scalebar. In Fig. 2b give vertical and horizontal scalebars in metres. Give

color scales and north arrows for all the panels. Alternatively use orientation of Fig. 1 also here and say in caption that they are all S-N oriented. Give a reference for your statement that the basin is composed of soft deformation till.

Figure 3: Give lateral scalebars and increase font size. Give scalebar for main panel.

Figure 4: Indicate location of this figure in Figure 3 and give scalebar.

Figure 5: Dismiss this figure and combine with Figure 3. Also change references in text accordingly.

Figure 6: Give scalebar and again, be consistent with figure orientations. Take Figure 1 as basis for all other figures. Is there radiocarbon evidence for the scenario of ice persisting on banks?

Figure 8: Give scalebars. Are the color scales in 'b' and 'c' the same as in 'a'? Indicate location of profile more obvious.

Figure 9: Use smaller and white arrows. The different colors for the locations of lineations and GLs are enough.

Figure 10: Very nice figure.

Figure 11: Give scalebar.