

Interactive comment on “The internal structure of the Brunt Ice Shelf from ice-penetrating radar analysis and implications for ice shelf fracture” by Edward C. King et al.

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King et al. document the highly variable nature of the Brunt Ice Shelf and either document or hypothesize source origins and mechanisms for the various components. This worked is framed in the context of the role of ice shelf heterogeneity in controlling rift propagation. The observations are particularly unique and will make a valuable contribution to the literature on the topic. Below, I highlight a number of issues that I feel would strengthen the manuscript.

Pg 1, Ln 15 – This is a unique observation (compared to rift behavior on other ice shelves) and likely reflects the significant differences in ice thickness between the me-

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teoric blocks and ice melange, correct? On other ice shelves (e.g., Larsen, Amery), rift propagation is rapid through meteoric ice and slow through suture zones give their different material properties/fracture toughnesses, as you subsequently describe in the introduction. It might be worth making this point of differing behavior more explicit in the main text.

Pg 1, Ln 22: upstream dynamics of the ice sheet. This could be modified to include the “upstream and far reaching impacts of such changes”, and include a citation of Reese et al., 2018.

Pg 1, Ln 23-24: Previous work by Hulbe et al. (2010) on the Ross Ice Shelf, Walker et al. (2015) on the Amery Ice Shelf, and McGrath et al. (2014) and Borstad et al. (2017) on the Larsen C ice shelf have also suggested and documented this association in detail. A more comprehensive review of the relevant literature is appropriate here since this forms the overriding context for the manuscript.

Pg 1, Ln 27: What is meant by “the suture zones can deform more rapidly without fracturing”? In previous work, authors have noted that rifts are frequently arrested by suture zones, suggesting that these flowbands have a higher fracture toughness than the neighboring meteoric ice. Can you clarify the connection between the more rapid deformation and the observations of rift arrest?

Pg 1, 26, 28:29: Is there a suitable citation for the viscosity of marine ice? In my opinion, it is overly simplistic to attribute the observations of rift arrest solely to the likely unique (but largely unmeasured) material properties of marine ice. As your findings suggest, ice mélanges and suture zones are highly heterogenous with numerous sources and numerous processes at play, and at present, I don't think we really know which of these unique characteristics (temperature, water content, altered crystal fabric, existing flaws/fractures) are responsible for arresting rift propagation. As such, it seems appropriate to acknowledge this complexity, which your findings corroborate.

Pg 2, Ln 11: What is the scale of the “large blocks”?

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Pg 2, Ln 11: What is meant by the inner part of the ice shelf? Can this be labeled/marked on Figure 2?

Pg 2, Ln 22: Replace “the early system” with “previous efforts.”

Pg 3, Ln 5: Given the significant topographic relief and ice velocities, how were the various DEM images from the two year interval aligned? What number of DEMs were included?

Pg 3, Ln 24 (and Figure 3): What is the source for the ice velocities?

Pg 3, Ln 25: The GPR observations are occurring over a highly heterogenous ice shelf, with likely significant spatial and vertical variations in ice density. In this context, can you describe your radar velocity derivation? Is this assumed constant across the ice shelf? If so, what uncertainties does this introduce to the analysis?

Pg 4, Ln 5:25: What are the uncertainties on these depth estimates given radar velocity uncertainties?

Pg 7, Ln 5: What is the actual statistical correlation between backscatter amplitude and the radar derived topography? Although the authors are only noting “its existence,” it would be worth discussing C-band depth penetration in more detail.

Figure 6: Add scale bar.

Please include Figure 13.

References

Borstad et al., 2017, Fracture propagation and stability of ice shelves governed by ice shelf heterogeneity, *Geophysical Research Letters*, doi:10.1002/2017GL072648.

Hulbe et al., 2010, Propagation of long fractures in the Ronne Ice Shelf, Antarctica investigated using a numerical model of fracture propagation, *Journal of Glaciology*, 56, 97, 459-472.

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McGrath et al., 2014, The structure and effect of suture zones in the Larsen C Ice Shelf, Antarctica, JGR ES, doi:10.1002/2013JF002935

Reese et al., 2018, The far reach of ice-shelf thinning in Antarctica, Nature Climate Change, 8, 53-57, doi: 10.1038/s41558-017-0020-x

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