

Review of “Calving cycle of the Brunt Ice Shelf, Antarctica, driven by changes in ice-shelf geometry” by De Ryt et al. - Joe Todd

This study combines multiple observational records with inverse modelling to study the ice dynamics, stress & fracture of the Brunt Ice Shelf. Data from satellites & in situ measurements are assimilated into the SSA model \dot{U}_a to invert for the flow parameter A across the shelf, and the resulting stress maps are analysed to build up a timeline of ice shelf stress conditions before, during and after the re-activation of Chasm 1 and the propagation of the Halloween crack. This is an interesting and well-presented study which warrants publication in *The Cryosphere*; as the authors note, the ‘natural’ cycle of stress concentration and release on ice shelves is a major factor controlling calving. I strongly agree with the conclusion that full-thickness rifting should be resolved in ice-sheet models. I think the manuscript could benefit from some additional details on the modelling results and some clarifications.

General comments:

It is not totally clear from the figure captions & text whether the stress maps shown in Figs. 2 & 3 come from \dot{U}_a model output. I can see 3 possibilities: (1) The stress maps are produced using observed velocity (from which strain can be derived) and an assumed constant flow parameter A . (2) As above, but A comes from \dot{U}_a output. (3) The stress maps are a direct output of \dot{U}_a simulations. The text strongly implies (3) but, from reading the methods section, I do not think that any fractured domains were studied with the model. Is rifting accounted for through inversions (i.e. low A where rifts exist)? If (3) is the case, more details should be added to explain how the rifting is accounted for. If (3) is not the case, clarifications and modifications are required in the text to avoid giving a false impression to the reader. It would be nice to see the results of the model inversion (maps of ‘ A ’) and this would probably also help clarify the point above. In general, it’s just not very clear at present exactly *how* the model was used.

Specific Comments:

P3L9-10 – Can the broad-scale pattern of ice shelf thinning be established? Paolo et al. (2015) seem to provide data which covers the BIS. You make a compelling argument for the first-order importance of internal dynamics/heterogeneity for crack propagation, but does this completely preclude any external environmental signal?

P4L3: This sentence implies that all the stress results shown in the paper are U_a model output. Is that the case?

P4L8: Could you show the inverted-for A parameter, perhaps in supplementary material? Presumably there are some pretty interesting patterns.

P5L3-11: I am not totally clear what the approach is here. How do you shift the DEM to an effective timestamp? What does the LIDAR data provide?

P6L14: Again, this strongly implies that Fig 2 & 3 represent model output.

P6L26: ‘Ocean pressure acting on newly formed rift surfaces’ - I’m slightly confused by this. On a floating shelf, the overall ocean pressure should be equal to the cryostatic pressure which existed before the crack formed. The exception, which I guess applies here, is if the intact shelf was under significant tension. But is it really accurate that the ocean pressure is pushing the rift apart? I’d have thought that it’s the concentration of the supported stresses onto a narrower band (the remaining intact ice) which promotes further fracture growth.

Fig 1 or 2: As I was reading the results section, I was thinking it'd be nice to clearly visualise the compressive arch. Could you perhaps add a panel (or overlay Fig 1a) showing regions with extension in both directions, versus one compressional component (like Doake et al., 1998).

Fig 4b: Observations & model match well to the south of the MIR, but the difference grows further north. Can you speculate why?

Minor Comments:

P2L27: A bit pedantic, but I think 'single' would be better than 'singular' here. 'Singular' tends to refer to an exceptional event or thing.

P3L15: 'preconditions for rifting were re-established'. What were these preconditions? I think the rest of the paper lays out what these preconditions were, but its perhaps a little premature to say this here without explanation.

P3L18: 'singular' again

P4L11: slight formatting error – ref in brackets

Fig 1: North arrow?

Fig 2: Unless is really reduces the clarity of the figures, I'd think that for a colour scale with a white minimum, the minimum ought to be 0 kPa.