

The Cryosphere Discuss., referee comment RC2
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Comment on tc-2021-296

Anonymous Referee #2

Referee comment on "Automatic delineation of cracks with Sentinel-1 interferometry for monitoring ice shelf damage and calving" by Ludivine Libert et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-296-RC2>, 2021

Libert et al. map the growth of a rift on the Brunt Ice Shelf, making use of the high frequency of Sentinel-1 imagery to provide a time series of crack evolution. Their interferometric method using edge detection of phase gradient magnitudes has an advantage over interferometrically-derived strain fields in that it does not rely on phase unwrapping, however, it has a disadvantage over other rift detection techniques (for example backscatter contrast or edge detection in optical imagery) in that it requires multiple images, with good coherence between image pairs. The method accurately tracks the location of a rift on the Brunt Ice Shelf. It also approximates the timing of rift growth. The timing is not validated by other observations, so it is currently difficult to assess the accuracy in detection of the rift tip itself.

The delineation of the rift is dependent on multiple (presumably tuned) threshold parameters, various stages of filtering and line cleaning to reduce unwanted noise. This appears to be a careful balance between keeping real cracks and removing artefacts. It would be valuable if the authors explained how the parameters are determined.

The paper is well written and provides a useful dataset for this particular ice shelf, but whether it would be valuable to apply to automatic crack detection on other ice shelves, given the added complexity and data processing requirements associated with interferometry and the lack of evidence that there is any improvement in positional accuracy, or detection success, is not clear.

Specific comments:

Line 23: I don't think you should link fracturing and damage development to climate warming here. The large independent rifts you observe on the Brunt Ice Shelf are not related to climate warming and I have some doubts that your method would work well in areas where this is the case, for example where there is dense damage / cross-cutting cracks or complex shear margins.

Line 43: sp `...the majority of ice shelves are routinely monitored...`

Line 54-55: There is published work that suggests that SAR backscatter imagery can be used to detect narrow cracks under the right viewing geometry (e.g. Thompson et al., 2020, 10.1016/j.coldregions.2020.103128)

Line 107: It is not necessary to repeat what you are about to say in the next section

Line 223: I expect that in the event of a crack opening in pure mode I extension parallel to an ice shelf front, while the velocity may be different on either side of the crack, the phase gradient may not show a significant difference. In this case, edge detection on your offset tracking output may work better. Have you compared this to the interferometry?

Line 249 – 258: The method appears to suffer both from false positives and false negatives. The Halloween Crack was active during this period (continuing to widen by almost 0.5 m / day in the center).

Line 288: Does this 9 x 9 refer to the value for 'w' in the previous section? It would be useful to restate here (i.e. $w = 9$).

Paragraph 288: As the method is described as automated it is important to explain how these values were determined. What is the sensitivity of the results to these values? Do these parameters need to be changed if the velocity is different, or if the coherence is worse, or under a different viewing geometry, or on a different ice shelf?

Figure 10: There are only 7 points on this graph, but you say that 32 interferograms were generated (including 9 not used due to coherence issues). It would be useful to add the other 16 points, even if the detected crack length does not change between interferograms. The crack moves in discrete jumps and any periods of no movement are also of interest. This would also help readers to assess the uncertainty in the method.

Line 363: While it may be difficult to delineate the rift in Sentinel-1 backscatter, it was

visible in Landsat-8 at a similar location to the interferometry on 19th January and almost fully visible to the Stancomb-Brunt Chasm by the 6th February, suggesting there is not necessarily a significant information gain using this InSAR method, relative to optical imagery.

Line 366: This sentence is a bit odd, consider rephrasing.

Fig 12 (a-c): As the fringes are fairly close, it is not immediately obvious from the figures that the color order of fringes is reversed on one side of the crack with respect to the other. This is an important point to highlight that the change in velocity is opposite on either side of the crack (particularly given that the fringe frequency is similar). This could be mentioned in the text to draw the readers' attention.

Line 410: You should probably refer to strain rate (as they are being measured) rather than stress.

Line 443: What do you mean by 'could be misinterpreted as ice flow acceleration by offset-tracking'?

Line 449: The derived rift growth pathway agreeing with the final calving pathway does not fully demonstrate the suitability of the approach for understanding the timing of rift growth. Would it be possible to validate the derived rift tip via other means (e.g. optical imagery)?

Line 456: Again I am not sure what you are referring to here with respect to ice flow speed up vs ice drift.