Replies to referee #3:

Thanks for your comments and suggestions. Please find below point-by-point replies (in blue) to your comments and questions (which are reprinted in black).

Overview

Dinh et al. present a phase-field model of sea ice intra-floe fracture. The method is interesting but the analysis of model simulations is cursory. With some additional simulations and analysis this work would be suitable for publication in the Cyrosphere.

Main comments

- The analysis presented uses a single type of imperfection in the ice pack, namely a fixed number of linear imperfections. Please provide a discussion on why this particular imperfection type was used (i.e. why is it the most appropriate for sea ice) and what other types could be used instead. Also, a brief analysis of the effect on varying the number of imperfections would add to the analysis.

  We chose linear imperfections because they are a simple model that spans a range of configurations that lead to different crack profiles. We emphasized that while simple, this choice includes interesting features such as intersections, spanning lines, short lines and networks of weaknesses. Alternative models could include Gaussian random fields e.g., generated with Matern kernels. However, these random models typically generate smooth realizations and thus they might not encourage crack nucleation (and not be more realistic for ice floes that our simple line models). We will explain our preference towards simplicity and discuss potential alternatives in the revised manuscript.

- Figure 3 shows two large peaks significantly higher than the rest of the histogram. Are these statistically significant and if they are what is their cause?

  These are likely sampling artifacts. We will look into these and update the draft if they persist and thus have physical meaning. Otherwise, we will discuss that the peaks caused by the sampling.

- The analysis in section 3.3 is a quite cursory. I would like to see the analysis presented in figure 4 repeated for other quantities other than just average thickness. It would be interesting to see it repeated with the minimum thickness and with the summed thickness deficit from all the cracks. Also, the average angle of linear ice features used in the analysis (equation 12) should be repeated with weighted averages such as weighted by feature minimum thickness, visible length, or thickness deficit.

  We experimented with other quantities, similar to those suggested, but did not include them in the manuscript as they did not show significant trends. The lack of trends is noteworthy and will be commented on in our other statistical investigations.

- The analysis only considers tension fracture, potentially to avoid complications with ridging in convergence. Some analysis on simulations with shear forcing are warranted though.

  We agree that simulations with shear forcing are warranted. As also noted in our response to Damien Ringeisen, we plan to extend the study with a shearing experiment and possibly a compressive one as well.

Other comments

- Line 12: "ice area concentrations" → "ice concentrations"
- Line 13: "have impact" → "have had an impact"
- Line 89: "Degeneration near the crack" - describe what this means
  We will correct the above typos.
- Line 143: Expand briefly the discussion on one dimensional solutions.
  We will add a short discussion.
- Equation after line 162: It would be useful to see a small diagram of what this crack cross section looks like
  We will add it to the paper or an appendix section.
- Figure 4: The brightness-based colorbar used for this figure makes the described important features hard to see. I think the figure would be clearer with a color based colormap
  We will revise this figure. Thank you for your suggestion.
- Line 227: This single line paragraph should be merged with another paragraph
  We will merge the paragraph.
- Figure 5: Same comment about colormaps as figure 4.
  We will adjust the colormap.
- Line 283: "theoretical results of Neitzel et al. (2017)" - describe briefly what these are
  We will add a description.