

The Cryosphere Discuss., referee comment RC1
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Comment on tc-2021-391

Anonymous Referee #1

Referee comment on "Wave-triggered breakup in the marginal ice zone generates lognormal floe size distributions" by Nicolas Guillaume Alexandre Mokus and Fabien Montiel, The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-391-RC1>, 2022

The authors use a 2D wave–ice model involving wave scattering, viscoelastic dissipation and a strain breaking threshold to conduct a detailed statistical analysis of the steady-state FSD produced by wave forcing. Strong evidence is given that the model predicts lognormal FSDs. The study is communicated clearly and the key outcome is potentially a valuable contribution towards modelling the marginal ice zone.

I recommend revisions before publication.

The Introduction is missing an overview of the considerable literature on modelling wave propagation in the MIZ. At present, readers could be led into thinking that the model used is accepted by the community, when, as the authors surely know, debate and open questions remain. There are, for example, different methods for modelling wave scattering and many different models of viscous damping. Certain models have been validated using experimental data. A similar comment applies to models of ice breakup caused by waves. It should be clear at the end of the overview why the particular wave propagation and ice breakup models have been chosen for the present investigation.

The two paragraphs starting from the bottom of page 2 are not particularly relevant for the study presented (e.g. the ideas are not picked up again later) and would be better in Sect 6, leading into a discussion on how the proposed model and findings could be implemented in CICE, etc. Sect 6 would also be strengthened by comments on possible implications of the reduced dimension of the model (e.g., in comparison to the 3D model of Montiel & Squire, 2017) and whether the predicted FSD properties are consistent with the ideas used by Dumont, Williams and co to parameterize power-law FSDs (such as the maximum floe size being half a wavelength).

At the beginning of Sect 5.1, the move from monochromatic to polychromatic forcing requires more explanation and justification. Presumably the definition of the FSD for polychromatic forcing in equation (23) is computationally efficient, but is it representative of the ensemble average FSD created by (random) irregular wave forcing that obeys the prescribed spectrum? Can examples be given to demonstrate this? Better understanding of this aspect of the model will improve interpretation of the results. Incidentally, I was unable to find f_L and \tilde{f}_L when scanning back through the paper at this point. Perhaps the latter could be introduced in Sect 2.

A title that indicates the scope of the study would be better, e.g. *Model predictions of lognormal floe size distributions in the marginal ice zone caused by wave forcing*

Minor:

25: *With thinner and weaker first-year ice becoming dominant **in the Arctic***

28: Elaborate on the sentence starting *The individual description*.

55: The sentence on short time scales for breakup appears to contradict the steady state model assumption.

Sec 3.1: Similar wave scattering models should be referenced at the beginning of the section [1,2, etc], and any notable differences identified.

149: *travelling **and evanescent** ...*

170: For completeness, say that the complex roots can become purely imaginary for high frequencies and/or thick ice.

178: I think the phases are used to *normalize* rather than *cancel out* the exponential terms.

Eqn (13): Replace the full stop with a comma.

248+250: for every **floe** and none of the floes **break**

253: Give the distribution used to randomly redistribute the floes after breakup.

258: Give details on the local resonances plus references.

Figure 3d: The levelling off/decrease of the median floe size with increasing ice thickness for $T=8s$ is interesting and worth discussing in the text.

Figure 4 caption: State the amplitude(s) used.

348: Space needed after the full stop.

428: Note that the value $\gamma=13.5 \text{ Pa s/m}$ was derived from measurements in the Antarctic MIZ [3].

Mathematics needs a capital M in the institution name.

References

[1] Kohout+Meylan, 2008, Journal of Geophysical Research, 113

[2] Montiel et al, 2012, Journal of Fluids and Structures, 28

[3] Massom et al, 2018, Nature, 558