Review of “Aerial observations of sea ice break-up by ship waves”
by Dumas-Lefebvre & Dumont (2021)

This paper is quite a good one and is one of the first to capture a break-up event in the field that is solely caused by waves. I’d recommend minor revisions.
I have some specific comments below.
Regards,
Timothy Williams

Specific comments

- p2 “*Floe size is also important for constraining wave propagation and attenuation...*” I would make it clearer the differences between parametrisations depending on FSD and physics which is still largely unknown.

- P3 “*By assuming that ice breaks up where the deformation is maximal, Roach et al. (2018) obtained that the fracture of sea ice by waves leads to a preferential size. This means that wave-induced break-up leads to a bell-shaped FSD, a result that indicates that the morphology of floes resulting from breakup might not be well represented by a power law*”. The bell shape in this case probably corresponds to peaks in the wavelength spectrum since there are no hydrodynamics in their model (they create a surface profile from the open water spectrum)

- p3. Mokus & Montiel (2021) could be worth discussing – they produced log-normal FSD from hydrodynamical simulations.

- p4. “*Indeed it is possible to study wave-ice interactions in laboratories as Herman et al. (2018) did, but it is not clear if the results directly apply to the natural environment due to the difference of scale and properties between laboratory-grown ice and sea ice.*” It should be clarified that the current experiment is not completely full-scale as the waves from the ship were very short compared to “natural” waves.

- figs 8-10: captions don’t say which expt is which

- p13: the area-weighted PDF does indeed seem more representative and also has a convenient corresponce to FSD formulations in models like in Roach et al (2018)

- p15: it was useful to have this information about the origin of x* here. There was a mixture of beam and thin plate here though – moment of inertia for a beam is [width][thickness]^3/12 and no Poisson’s ratio; for a plate EI is swapped for the flexural rigidity Eh^3/(12(1-nu^2)).

- P16. Good point about the half-wavelength and x* lengths corresponding to maxima in deformation. Here could be a good point to mention Asplin (2012), who noticed breaking into strips of half-wavelength in a place far from the ice edge. As in the Mellor quote, it seems like the presence of the ice edge is quite important, that the break-up occurs so fast (after very few cycles) that the fracture always seems to occur at the closest maxima to the edge which you and Herman et al (2018) found to be correlated to the x* length. Another paper which could be relevant is Williams and Squire (2014) who looked at results from a hydrodynamic model to see that maxima in long floes were separated by half a wavelength (more like the Asplin case), but they didn’t look at the distance from the ice edge to the first maximum.

- P17. Not totally convinced of the importance of fatigue since it sounds like the break-up front is advancing very fast. Maybe it is important at the end of the MIZ – perhaps there is more spread in floe size there?

- P18-19: “*which is close to ½, the ratio … in deep water*” should maybe change to “*for deep water without any ice cover*” The thing to look at would be the change in wavelength going from open water to choose the dispersion relation and then calculate the group velocity, rather than assuming the break-up front advances at the group velocity. The work of Sakai & Hanai (2002) would be relevant too, who showed a transition from elastic plate to mass loading behaviour as floe length decreased (with artificial floes in a laboratory) so fragmented ice behaving in a mass loading way is consistent with this. It would be an interesting result though if c_b and c_g were about the same, and would make some sense as well.

- Eqn (16): maybe a transmission coefficient should be multiplied by a_0 to get the amplitude in the ice? This would be smaller for thicker ice, making the 2nd attenuation coefficient even smaller compared to the 1st. The difference is indeed marked between the 2 cases. Another counterintuitive thing is that the thin ice is broken into smaller floes which would scatter less and would be expected to have lower attenuation than the longer floes. Other FSD-dependent parameterisations like creep also attenuate waves less when the floe size is lower. Perhaps there is more friction between floes or something like that (bigger perimeter), but like you say that is a bit out-of-scope.

- p22: “*The modal shape of the FSDs informs us that sea ice breaks up systematically at strains lower than the extrema such that material fatigue is of important when considering breakup (Langhorne et al., 1998)*”. I don’t follow this argument – it shows that there is a preferential length scale doesn’t it? The spread around the mode could come from many sources (as you say in the next sentence a bit) – ice heterogeneity (as you mention), an irregular ice edge, waves from a spread of angles. Ship waves are curved also – this could maybe have an effect over a longer distance into the ice.

typos

- Fig 4 caption: maltab → matlab

References

Asplin, M. G., Galley, R., Barber, D. G., and Prinsenberg, S. (2012), Fracture of summer perennial sea ice by ocean swell as a result of Arctic storms, *J. Geophys. Res.*, 117, C06025, doi:10.1029/2011JC007221.

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Sakai, S., & Hanai, K. (2002, December). Empirical formula of dispersion relation of waves in sea ice. In *Ice in the environment: Proceedings of the 16th IAHR International Symposium on Ice* (pp. 327-335).

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