The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC3
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# Comment on tc-2022-75

Anonymous Referee #3

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Referee comment on "A collection of wet beam models for wave–ice interaction" by Sasan Tavakoli and Alexander V. Babanin, The Cryosphere Discuss., https://doi.org/10.5194/tc-2022-75-RC3, 2022

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Theoretical model
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The theoretical model is
- purely elastic ice, or damping in the ice from the imaginary part of the Young's modulus. The specific formulation for the damping comes either from the Kelvin-Voigt or the Maxwell rheology and gives different frequency dependance in the damping coefficient.
- damping in the fluid from B, the radiation damping coefficient. (This is the same as the Robinson-Palmer model.)
- extra inertia from A, the added mass coefficient

The main novelty to me are the different ice rheologies, but the fluid damping effectively has little novelty (with the exception of A) but only introduces a more complicated (and physically more dubious) justification for the Robinson-Palmer (RP) model. I would remove the physical justification completely as (a) unnecessary and (b) physically dubious. (Note I am not proposing to remove the RP model itself as applying an old model to new data can still be interesting.)

I say it is physically dubious as the added mass and damping are usually derived from solving the hydrodynamic equations (Laplace's equation + sea floor condition + boundary condition (7)) with A=B=0 when a body is forced to oscillate. So to put them into (7) seems a bit circular. (Incidentally, in equations 5 and 6, $z^4$ should be $z_{xxxx}$.)

In the authors' reply to Reviewer 2, they talk about continuum media (I guess effective media). Maybe they are trying to represent the attenuation due to scattering by a large number of scatterers. Phase-resolving scattering models do predict that wave energy does decay into ice but they also conserve energy. While they would not be the first authors to represent the attenuation due to scattering with a dissipative model (eg Williams, Bouillon & Rampal, 2017, The Cryosphere)(for lack of a good alternative), they aim to represent it entirely with Robinson-Palmer dissipation instead of empirically, as most authors do.

It should also be noted that scattering models give quite different results to Robinson-Palmer especially at long periods, and since Robinson-Palmer (combined with the dissipation inside the ice itself) gives realistic results in these case it begs the question of why they are bringing in scattering at all.

## Results

- right hand columns of fig 2 not needed
- why not just have $k_i$ instead of $\alpha$ since the attenuation is only coming from the dispersion relation?
- ice rheologies give different attenuation behaviours (peaks in attenuation) at high frequencies. This is interesting that peaks can be produced with different rheologies. However, once you start to introduce more complexity (I am thinking especially of the SLS models) there are more parameters to be tuned and there is a danger of overfitting. Moreover, the peak in attenuation may not be real as instrument noise and local non-linear wave generation of high-frequency waves can give the appearance that high frequencies are being attenuated more than they are (Thompson et al, 2021, J. Geophys. Res.), so trying to fit them too accurately may not be wise.