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An elastic plate model for the attenuation rates of ocean waves in the marginal ice zone

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We present a model for wave attenuation in the Marginal Ice Zone (MIZ). The model is based on a two-dimensional multiple floating elastic plate solution in the frequency domain, which is solved exactly using a matched eigenfunction expansion. The only physical parameters which enter the model are length, mass and elastic stiffness (of which, the latter two depend primarily on thickness) of the ice floes. The model neglects all non-linear effects as well as floe collisions or ice creep, and is therefore applicable to floes which are large compared to the thickness and to wave conditions which are not extreme. The solution for a given arrangement of floes is fully coherent and the results are therefore dependent on the exact geometry. We firstly show that this dependence can be removed by averaging over a distribution of floe lengths (we choose the Rayleigh distribution). We then show that after this averaging the attenuation is a function of floe number but independent of the floe length, provided that the floe lengths are sufficiently large. The model predicts an exponential decay of energy, exactly as is shown experimentally. This enables us to provide explicit values for the attenuation coefficient, as a function of the average floe thickness and wave period. Finally we compare our theoretical predictions of the wave attenuation with measured data and with other scattering models.