Dear Chris

The work shown here is extremely exciting. The inclusion of wave-breaking and a true floe thermodynamics into CICE is an important step towards improving sea ice models, and I look forward to future work implementing this model.

Thanks for your interest in our work and your useful comment.

I wanted to bring up an important, and subtle, issue that I feel should be addressed in this communication and going forward. On pg. 4 line 5, ≪The floe-diameter parameter is a tracer field in CICE, and is transported within each ice category to give the total floe-size distribution at the end of a time step≫. The mean floe diameter, however, does not advect as a tracer.

⋮

Quite possibly the proper mean floe size advection scheme is unimportant, but as you are the first to introduce this type of model, it is unclear, and is exciting to find out. If future models include a fully-evolving FSD, this fix will no longer be necessary.

We consider a "representative" diameter in each cell, as opposed to a mean diameter with respect to a distribution. We set the representative diameter to be the mean diameter of a split PDF if breakup occurs, but without attaching the PDF to the cell, as this would be inconsistent with the Steele model, which considers only a single "average" diameter.

Following the wave–ice routine and lateral melt, we transport the representative diameter by:

(i) Setting the floe diameter to be identical for each thickness category, and transporting the floe diameter as an area tracer for the different categories.

(ii) Setting the new representative diameters to be the diameters of the thinnest ice category (cat. 1).

Step (i) is valid with respect to area normalisiation (a delta function in the FSTD, with respect to floe size). Step (ii) is merely a simplifying assumption; however, it does not impact our results, as shown in the figure below. The figure shows a subset of the data from the left-hand panel of manuscript Fig. 2, comparing the mean–monthly ice concentration at the ice edge during January generated by simulations without breakup (×) and with breakup (•). Additional results are overlaid for the first 12 simulation years, in which part (ii) uses the diameter of cat. 2 ice (∗) and cat. 3 (□), neglecting thicker ice categories for clarity and on the basis that thinner ice is most prevalent at the ice edge. Cats. 1–3 give virtually indistinguishable results, indicating that "the proper floe size advection scheme is unimportant" – at least for the metrics we focus on in this investigation.

In the revised manuscript, we have expanded the passage on transport of the representative diameter to include the key points of the above discussion.

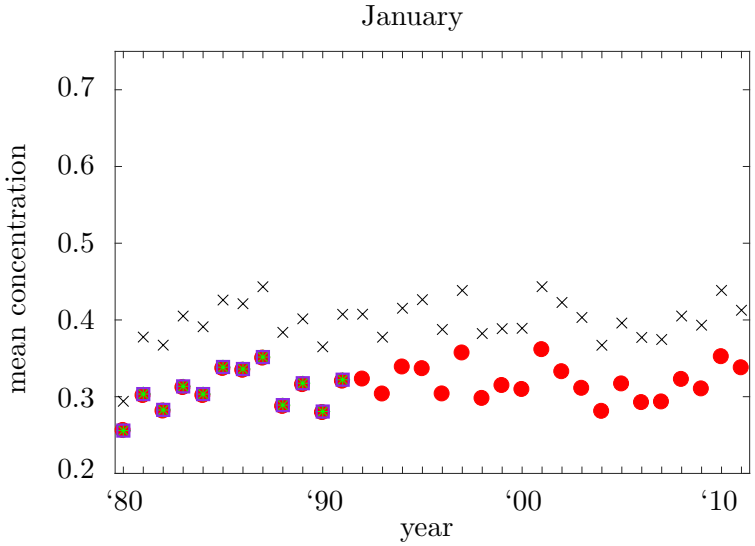

Figure: The left-hand panel of manuscript Fig. 2, excluding data from the smaller/larger floe sizes and attenuation rates, and including results in which the representative floe size following advection is set to the floe size of cat. 2 ice (∗) and cat. 3 (□), rather than cat. 1.