WIFF1.0: A hybrid machine-learning-based parameterization of Wave-Induced sea-ice Floe Fracture
Horvat & Roach (2021)

General comments

- This an interesting and well-written paper although I would recommend revisions (somewhere between minor and major) before publication.
- It makes a lot of sense to use a NN to update the FSD depending on the wave field/ice conditions etc, although maybe it should be more flexible (eg having the breaking threshold as an input parameter to the NN).
- One question is if a NN classifier is the best thing to use or can a simpler criterion be applied (eg a threshold in the variance in the strain) that would be
  i. simpler and faster
  ii. physical (as opposed to a black box). I would also mention the paper of Voermans et al (2020) (see https://tc.copernicus.org/articles/14/4265/2020/) who seemed to find such a threshold empirically by collating several observations of sea ice break-up in the presence of waves. This paper is conspicuous in its absence from the bibliography by the way.
  iii. flexible as opposed to being fixed during the training.

Specific comments

- P2 l50: Training on model output is a good idea for generating a variety of input wave spectra, but there is potentially other confounding factors – more details could be provided – hopefully it is still only the input and output of the SP-WIFF that is used for training?
- P2 L50: A year should be long enough to give enough variety in conditions – eg from regional, seasonal differences.
- P4 l95: Perhaps add the RELU acronym for the activation functions as probably not many people know what it stands for (including me)
- P3: S1, S2: why does the algorithm need to converge when there is no ice-to-wave feedback?
- P4 l101, l107-108: you talk about SIC and SIT histograms, but you only input the mean SIC and SIT to the NN? Is the model run with a joint thickness/size distribution or is there just one FSD for all thickness categories?
- Fig 1
  - add “run rate” definition to caption? (I see it is defined later in the text, but it took a while to find it). Can you also define “false positive/negative rate”?
- P6 eq 5: was there a reason for wanting to weight errors in the bins for higher floe sizes more than the bins for smaller ones? Otherwise a simple RMSE might be enough. Another possible metric for comparing PDFs are the Kolmogorov-Smirnov test (this may not be differentiable, but could be used in evaluation). The SSE you’ve defined is reasonable though.
- Discussion: perhaps an example that could be quite pertinent to the current paper is to speed up calculation of source terms in WW3. In addition, the SP-WIFF could be enhanced by allowing some ice-to-wave feedback and could possibly output a wave source term as well as the FSD.
- For some setups (eg if an interface like OASIS-MCT were used in the wave-ice coupling), using NN-WIFF as provided would require the full wave (frequency) spectrum to be passed to the ice model which is quite costly. Perhaps some kind of dimensionality reduction could be performed to reduce the parameters that had to be passed? This could possibly be done with a NN as well, in order to fit in with the current structure.
- Fig 5, bottom row: 2 orders of magnitude difference in 4.5% of the total sea ice area is not so small; it becomes more significant as a fraction of the MIZ. Since (as you note yourselves) this is on the MIZ-pack boundary it could be worth another look at the classification – I think it is worth another trial run with the classifier replaced by a simpler and perhaps more stable criterion.

Typos

- P2 l5: “it overall computation times by an order of magnitude” to “it increases overall computation...”
- p3 l61: equation should possibly be something like this

$$S(\lambda) = \int_0^{2\pi} S(\lambda, \theta) d\theta$$

?

- P11:Integrating these simulations *using on* the Cheyenne supercomputer
- p11: “NN-WIFF reduces the overhead associated with simulating wave-ice fracture without significant added computational cost” to “ NN-WIFF reduces the overhead associated with simulating wave-ice fracture”?
- p12 l61-62: “Because of the ease of obtaining training data from climate model output, this parameterization acceleration approach has, and could continue to, find” - “… has found,… to find,”
- p12 l266: paramterization,