

Interactive comment on “On the statistical properties of sea ice lead fraction and heat fluxes in the Arctic” by Einar Örn Ólason et al.

Anonymous Referee #1

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This manuscript compares the statistical properties of sea ice lead fraction simulated by the neXtSIM sea ice model to satellite observations, then presents heat fluxes simulated by the model, discusses the impact of model resolution on results, and proposes a physical explanation for the semi-log tail in the probability distribution of simulated heat fluxes. The manuscript is novel and generally well-written, although some statements require citations (noted below). I recommend this manuscript for publication if my major comments below are addressed.

The manuscript would benefit from some further discussion for the general reader that better situates the findings in the context of the published literature and suggests implications for the broader scientific community, rather than simply for the development of neXtSIM. For example, why is it the mono/multifractal scaling interesting? Does the

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work suggest parametrizations that could be used in traditional climate/sea ice models? This comment is merely a suggestion and the authors are not required to address it.

Major comments

I find the exclusion of the Beaufort Sea from the model-observation comparison to be poorly motivated. The model-observation comparison does not seem fair if the authors exclude regions where the comparison is poor. The authors need to motivate the exclusion of this region better and quantify to what extent the exclusion of the region affects their conclusions, or refrain from excluding it in their analysis.

Data availability – According to The Cryosphere data policy, ‘Authors are required to provide a statement on how their underlying research data can be accessed.’ This is missing from the manuscript.

Line-by-line comments

L7 Wasn’t the Central Arctic region chosen to avoid the presence of polynyas?

L18 ‘In particular ...’ – add citation(s)

L19 ‘Leads ... are a much more temporally and spatially clustered gateways’ – this is unclear, please revise

L25 ‘causes’ .. ‘causing’ – repetitive, rephrase

L32 Missing parentheses

L33 What area did the satellite image cover?

L36 ‘accurately reproduce the properties of lead fraction statistics’ - add citation(s)

L43 In what situations does the mixed layer deepen in response to brine rejection? My understanding is that this is what occurs in low resolution models. Barthélemy et al. (2015) (<https://doi.org/10.1016/j.ocemod.2014.12.009>) could be cited here.

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L48 'is actively being researched' – add citation(s)

L49 'Lead formation is closely linked . . .' – add citation(s)

L54 Suggest defining multifractality here.

L55 'This fundamental property . . .' This sentence needs more explanation for the general reader.

L74 Please provide more details on the slab ocean. Does it include any representation of ocean currents? How might the simplicity of the modelling configuration affect results?

L95 Define 'node' and 'cohesion'

L99 'The deficiencies of the linear viscous model are well known' – add citation(s)

L109 How is it an improvement?

L126 Why are the heat flux magnitudes provided as snapshots rather than daily means?

L154 Reword 'for future works' to 'in future work'

L167 'that gives good statistics.' What does this mean?

L168 Why not simply use a threshold of 10 cm? How much does the choice of threshold affect the results?

L182 Why do you think the model does not capture this?

Fig. 1 caption – define the red dashed lines. 'read' -> 'red'

L191 'excellent agreement' The figure is in log space, so some of the model-observation differences seem not insubstantial.

Fig. 2 caption – are these lines excluding the Beaufort Sea? Typo in 'Arctic'

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L210 What is 'proper' spatial scaling?

L275 'after some algebra' – this wording is too casual for a journal article

L315 Reword 'this model shortcomings' to 'these model shortcomings'

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2020-13>, 2020.

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