The Cryosphere Discuss.,
https://doi.org/10.5194/tc-2019-88-RC2, 2019

The Cryosphere
Discussions
Open Access

Interactive comment on "Feature-based comparison of sea-ice deformation in lead-resolving sea-ice simulations" *by* Nils Hutter and Martin Losch

Anonymous Referee #2

Received and published: 19 September 2019

General comments:

The authors applied some newly developed tracking algorithms for Linear Kinematics Features (LKF) presented in a recent study by the same authors to two model simulations and RGPS data. This approach allows for direct comparison of various metrics of LKF, namely the density, orientation, length, curvature, intersection angles, persistence and growth rates. This study represents a sophisticated assessment of a model's dynamical features. The presentation is clear, the model realism (in terms of those features) convincing, and some interesting results with obvious physical and operational applications. This paper also offers a contribution to a question that has been debated

repeatedly in the community as to the ability for the VP rheologies (and derivatives) to capture the power law distributions seen in the satellite observations. I find that the work is sufficient to justify publication in this journal provided that some of the major issue listed below are addressed.

1) Model tuning. How much of the results are the results of parameter tuning? The authors should make it much clearer if these two model configurations are their standard model simulations and if there was a tuning procedure to obtain such realistic fits to the observations. Additionally, has this tuning been to the detriment of other characteristics of the model (I..e thermodynamic characteristics, sea ice concentration, thickness and velocity). A supplementary plot showing how both models perform with regard to these essential sea ice metrics would be welcome. For example it would not be satisfactory to achieve better fit to the dynamics features discussed in the paper to the detriment of this more standard and important features of the sea ice cover.

2) References to the literature. While some section are well documented, I find other section do not do justice to previous authors who have worked on this theme. Besides the historical studies by Hibler, Coon, Pritchard, Gray, etc the authors also omit more recent work on the anisotropic rheology of Tsamados et al., Tremblay et al, Lemieux, etc. . .

3) Model resolution and forcing dependence of the results. The author present two model runs that differ in their ITD representation (without going too much into the detail of their difference) but fail to present a fair assessment of the sensitivity of their results to the model spatial (and temporal) resolution as well as to the forcing applied. Some definitions (overlap, persistence, etc. . .) are bound to be sensitive to the grid resolution and it would be useful to get a sense of this. An additional, difficult, question that is eluded is the degree of localisation of the LKF in this model. Indeed one crucial quantity of interest of these LKF is their width but the authors fail to discuss that point entirely.

4) Coupling of dynamics with other parts of the model. The authors treat the problem

and the LKFs as if they are completely separate from other components of their model. They make a brief reference to the ridging scheme and drag coefficients but fail to discuss further how modification of LKFs features could couple to other parts of the model.

5) Final major issue that this study uncovered is that the VP rheology fails to capture the intersection angles as they are observed in the observations. This is an important negative result but others have studied these angles before and should be referenced (Hibler, Hutchings, Pritchard, Grey, Ukita, Heorton, . . .etc).

Specific comments:

Abstract

P1L6: power law distribution better. Not all power distribution are multi-fractal in nature. P1L9: not an ITD simulation but a sea ice simulation with an ITD parameterization P1L17: addressed

1 Introduction

P2L4: rephrase P2L22: you mean individually? P2L29: one of which P2L34: rephrase P3L2: outline?

2 Methods 2.1 LKF detection and tracking algorithms 2.2 RGPS LKF-dataset 2.3 Model simulations 2.3.1 Model configurations

P3L28: Some have argued that power law is in the forcing? How sensitive are your results to the spatio-temporal lenghtscales of the atmo/ocean forcing? P4L8: we branch -> meaning? P4L13: justify this choice. Cite Landy et al, 2019 P4L19: bold not a good idea. i suggest run_ITD run_noITD

2.3.2 Sampling and LKF extraction

P4L32: what boundary? P5L9: contradicts power law distribution and localisation

2.4 Spatio-temporal scaling analysis

P5L15: and Weiss et al, 2018 for space-time power laws P5L29: this is not clear here and some repeat of earlier paper might be needed P6L9: than ...(L<L0/2) 2.5 Irregular temporal sampling of RGPS

P6L19: unclear sentences. What two streams are you referring to in this sentence? P6L33: Brief algorithm schematic needed in appendix or clear reference to previous paper, section etc. . .

3 Scaling in sea-ice deformation

P7L4: General comment: it would be good to know what tuning you have undergone to achieve such a good fit with the observations. P7L5: decreases P7L16: Can you also check the space-time scaling as discussed in Weiss et al, 2018 P8L11: Not clear if it is not good in this study or in Rampal's. Rephrase P8L16: how does this link with power law exponents? Explain P9L2: This is slightly too strong as they were developed also to represent some physical characterists (i.e. stress redistribution...)

4 LKF statistics 4.1 Pan-Arctic distribution of LKFs 4.1.1 Number of LKFs

P10L1:Important consideration is how the results presented below scale with model resolution but also with spatio-temporal scales of the forcing fields. P10L9: does not seem significant and also raises questions as to how LKFs are detected in a changing Arctic P10L22: any suggestions as to why? Generally little elements of physical explanations of the results are given. P10L33: Not clear to me how this relative density is calculated (what unit?) and how you can compare it to MODIS or CS2 information. For CS2 please also cite recent paper by Horvat et al, 2019.

4.1.2 LKF density

P13L17: Another possibility is that some of these features are ocean driven (geostrophic current or Eddies). There is extensive recent literature on this in this region, 4.1.3 LKF orientation

P14 Figure 6: over what period? Season? Specify in caption

4.2 Spatial LKF properties 4.2.1 LKF length

P15L7: good review P15L12: So not clear what method you use to measure LKF lengths

4.2.2 LKF curvature 4.2.3 LKF intersection angles

P16L29: Cite also study by Hibler and Hutchings, 2004, + several studies by Wilchinsky + Feltham + Tsamados + Heorton on anisotropic rheology with prescribed diamond shaped floes. Tsamados et al, 2013 describes sensitivity to this intersection angle See also papers by Cunningham et al, 1994, Schulson et al, 2006, but also Gray, Coon, Pritchard, Maslowski, Ukita, Moritz... P17 figure 9: So quite important structural difference of the model with reality here. P18L5: angles

4.3 Temporal evolution of LKFs 4.3.1 LKF persistence

P18L17: define lifetime calculation (algo). How model resolution is this? Do you calculate persistence in a lagrangian or eulerian way? P18L32: Why didn't you estimate similar biases for the other LKFs characteristics discussed earlier?

4.3.2 LKF growth rates 5 Discussion

P22L19: or indirectly in the anisotropic rheologies of Tsamados et al, 2013 via the additional dynamics on the order parameter controlling the degree of anisotropy P22L32: see also Heorton et al, 2019

6 Conclusion

Interactive comment on The Cryosphere Discuss., https://doi.org/10.5194/tc-2019-88, 2019.