Review of "Probabilistic forecast using a Lagrangian sea ice model: application for search and rescue operations" by Matthias Rabatel, Pierre Rampal, Alberto Carrassi, Laurent Bertino, and Christopher K. R. T. Jones

General comments

The manuscript "Probabilistic forecast using a Lagrangian sea ice model: application for search and rescue operations" by M. Rabatel, P. Rampal, A. Carrassi, L. Bertino, and C.K.R.T. Jones provides a comprehensive evaluation of sea ice drift response to uncertainties in wind forcing using the sea ice model NeXtSIM with elasto-brittle rheology. The authors demonstrate through comparison with what is referred to as a free-drift model anisotropic behavior associated with sea ice mechanical properties in winter, with implications for predictive skill. This paper presents novel concepts and tools to highlight the importance of characterizing sea ice mechanics and rheology for such applications as search and rescue operations in winter. It is recommended that this manuscript be accepted for publication, following consideration of aspects including systematic error in NeXtSIM as documented in earlier studies of this Lagrangian sea ice model, spatial variability in the air drag coefficient, boundary condition sensitivity studies, and further investigation of reasons for discrepancies in dynamics for modeled and observed trajectories. Please find below more specific comments for consideration.

This is also to express agreement with the comments of both reviewers on the quality of manuscript, in addition to statements in regards to justification for term selection in the free drift model, and the need for further description as to how the forecasts are initialized.

Specific comments

Introduction

p. 2, line 28. In Rampal et al. (2016b), the authors show systematic errors based on comparison of simulated ice drift with the GlobICE dataset (Figure 7). Perhaps note in the Introduction, and provide a figure depicting, the spatial distribution of systematic errors for given timeframes in winter and summer, to distinguish from differences due to compactness and rheology based on comparisons between NeXStSIM and the free drift model. Highlight systematic errors based on comparison with OSISAF.

p. 3, lines 22 – 29. What parameter values are used in the present study, and in particular for compactness (i.e. as in Table 2 in Rampal et al., 2016b)? In the sensitivity analyses for the compactness parameter in Bouillon and Rampal (2015a) it is noted that the opening and closing rates are influenced by the compactness parameter. How are the current wind sensitivity results influenced by the choice of the compactness parameter?

Sensitivity analysis

Air drag coefficient and other parameters: Will there be regional variations in the drag coefficients? How is spatial variability in the drag coefficients addressed? Is the calibration method used the same as that in Rampal et al. (2016b)? As previously noted, what value is used for the compactness parameter in this study?

> Specifically:
> p. 9, line 2 and reference to the OSISAF dataset. Are similar results and values obtained for the air drag coefficient using the globeICE drift product for comparison, as in Rampal et al., 2016b?
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> p. 9, line 6 and p. 8, Figure 2. Is concentration considered to account for spatial variability in the air drag coefficient, as described in Steiner (2001)? In addition, what impact does the drag coefficient have on results?

p. 8, line 15. Perhaps provide justification for this wind speed variance selection (i.e. a value that is 6 times smaller than that used in Sakov et al. (2012).

p. 9, Figure 3. Is it possible to also identify and show systematic errors spatially in another panel in this or a separate figure? Please see previous comments for the Introduction.

p. 10, line 5. 100 km initial spacing. Are results and differences between the NeXtSIM and FD models influenced by different initial spacings?

Results

p. 12, Figure 5. Should the contours for the lower panels be the same (i.e. <= 3 for both)? If not, perhaps emphasize the difference in diffusive spread spatial scales for the FD and NeXtSIM models since this, in addition to similarity in spatial patterns between minimum and maximum diffusive spread for both models is of interest and relevant to the present study.

p. 13, Figure 7. Similarly, the contour range should be the same. Sea ice dynamics are different for neXtSIM and FD even in summer. Perhaps include in the text a possible explanation for these differences (i.e. systematic error, parameter selection, FD characterization).

p. 14, line 15. '…effective elastic stiffness E depends non linearly on the ice concentration…' Should this nonlinearity (and spatial variability) also be considered when optimising for the air drag coefficient? Should this too be considered with optimising for the air drag coefficient? Please see previous comments.

p. 14, line 24. 'Where both (winds and ice thickness) are large, \gamma is large'. However, \gamma is also large in the southern Beaufort Sea for large winds and lower ice thickness in winter. Figures depicting maps of \gamma for the NeXtSIM and FD models in winter and summer would also highlight the impacts of ice rheology.

p. 15, Figure 9 caption. 'The PDFs for FD are similar for summer and winter…' Perhaps still show both PDFs in a separate panel with a different y-axis scale.

p. 15, lines 4 – 6. How are lateral boundary conditions (i.e. landfast ice and its extent) addressed in the model? Would sensitivity analyses associated with boundary conditions highlight regional differences in anisotropy and preferential orientation?

p .16 and Figure 12. What are the possible reasons for discrepancies between the observed and modeled ice drift dispersion characteristics and temporal scaling exponents, namely the superdiffusive regime, in summer? Could superdiffusive behavior be attributed to other sources of uncertainty responsible for systematic error in the model?

p. 17, Figure 11. Contour range should be comparable for the FD and NeXtSIM models. Is it possible to use the anisotropy ratio featured in Figure 11 to improve predictive skill for NeXtSIM?

p. 17, line 10. The forecast error vector components should be depicted accurately in Figure 15.

p. 19, Figure 14. How are **e**, **b**, and **a** related when considering the anisotropy ratio and is relation to forecast error? Variance in parallel and perpendicular components of b could also be compared with those for the forecast error in this figure or in figure 12 to demonstrate the anisotropic effects associated with elasto-brittle rheology.

p. 21, line 19. 'for an equal area that can be searched' Does this imply for a fixed area?

p. 25, lines 5 – 7. Would it be possible to quantify these contributions in additional sensitivity analyses?

Technical corrections

p. 1, line 12. Replace 'of free-drift' with 'the free-drift'.

p. 2, lines 33 – 34. Combine the sentence 'Without…' with the next sentence.

p. 4, line 10. Change 'spatial' to 'spatially'.

p. 5, line 24. Change 'analysis' to 'analyses'.

p. 6, line 25. Change 'informations' to 'information'

p. 7, Figure 1 figure caption. Perhaps replace 'bouquet' with '-member ensemble'.

p. 11, line 25. Please change to 'Chukchi'

p. 11, line 30. Please replace 'inn' with 'in'

p. 14, line 14 'influences'

p. 19, line 4 Replace 'get very' with 'are'

p. 21, line 19. Insert 'be' prior to 'posed'

p. 22, line 5. Perhaps replace 'allow as also' with 'also allows'

p. 22, line 27. Replace 'of' with 'by'

p. 22, line 30, Perhaps remove 'up'

p. 22, line 31, Perhaps replace 'reveals' with 'FD is observed'

p. 23, line 3, Replace 'sensitivity' with 'sensitive'

p. 23, line 6, Replace 'contrarily' with 'in contrast'

p. 24, line 21, Replace 'called' with 'considered'

p. 25, line 6, Remove 'yet'

Reference

Steiner, N., 2001: Introduction of variable drag coefficients into sea ice models, Annals of Glaciology, 33, 181 – 186.