Review of "A new tracking algorithm for sea ice age distribution estimation" by Anton A. Korosov, Pierre Rampal, Leif T. Pedersen, Roberto Saldo, Yufang Ye, Georg Heygster, Thomas Lavergne, Signe Aaboe, Fanny Girard-Ardhuin

General comments

The manuscript "A new tracking algorithm for sea ice age distribution estimation" by A. Kosorov, P. Rampal, L. Pedersen, R. Saldo, Y. Ye, G. Heygster, T. Lavergne, S. Aaboe, F. Girard-Ardhuin, provides a comprehensive analysis of techniques and data used to estimate sea ice age distributions. This paper provides a clear description of a new algorithm and product that results in improved characterization and understanding of sea ice age distributions. In addressing issues associated with unrealistic ice divergence and convergence resulting from artifacts in the NSIDC sea ice drift field, in addition to limitations associated with existing algorithms used to estimate sea ice age, this paper shows that the OSISAF sea ice drift product combined with the SICCI algorithm provides a reasonable and improved alternative to existing data products and algorithms traditionally used to characterize sea ice age.

The paper addresses in a comprehensive and coherent manner relevant scientific questions associated with sea ice age and its characterization. In addition, the manuscript builds on and presents novel concepts and ideas that contribute to an understanding of sea ice dynamics and implications for sea ice age distribution estimation relevant for data assimilation, validation, and machine learning development applications. Substantial conclusions, including the development of a product (OSISAF data and Eulerian tracking algorithm) to address inconsistencies in, and provide additional information beyond, what is provided in current data products, including sea ice age distributions at each pixel, are found. Furthermore, scientific methods and assumptions are clearly presented, including the Eulerian advection scheme with emphasis on advected sea ice age fractions, and ice age probability distributions. Interpretations of results and conclusions are supported by comparison between four scenarios and products, and with SAR-derived MYI extent. Additional reference to, and description of, existing studies that support the results from this analysis, including undersampling issues and an under-estimation of MYI sea ice extent using the NSIDC data product and Lagrangian approach, could be provided in the Introduction and motivation for the present study. Although the title accurately reflects the manuscript objectives, text within the abstract could be clarified to reinforce study findings and highlight the benefits of this approach for improved understanding of sea ice age distributions and MYI ice extent relevant for validation and assimilation applications. The paper is well structured, and formulae and figures clear. This is to recommend that the manuscript be accepted for publication with minor edits. Please find below specific comments for consideration.

Specific comments

Abstract

p. 1, lines 7 – 8. "Several improvements related to the usage of the new ice drift product, constraining the observed algorithm by the ice concentration and preventing undersampling by the Eulerian scheme are presented." Perhaps replace this statement with 2 – 3 phrases highlighting the key findings of the study, including the i) development of a new sea ice age product that combines OSISAF ice drift data with an Eulerian algorithm, ii) derivation of sea ice age distributions based on the additional constraint of sea ice concentrations, and iii) more realistic representation of MYI that addresses under sampling found using the standard Lagrangian approach and NSIDC ice drift product to characterize sea ice age.

Introduction

Additional studies that provide motivation and context for the present analysis could be included in the Introduction, with the paper by Rybak and Hubrechts (2003) as an example.

Data

p. 2, line 32. In response to the first reviewer's comment, perhaps note that earlier studies showing persistent artifacts also used version 3 of the NSIDC sea ice drift product.

Methodology

p. 5, line 5. Perhaps indicate the impact of uncertainty in ice drift and concentrations on the Eulerian advection scheme, in addition to pixel size relative to the floes considered.

p. 7, line 12. How do results differ for a different start date?

p. 7, line 19. 'We postulated that all observed ice is second year ice'. What are the implications of this assumption and an initially spatially homogeneous ice age distribution?

p. 8, line 10. It would be beneficial to compare these diagnostics with those used for the standard Lagrangian NISDC sea ice age algorithm, and to highlight potential applications for each, as is noted briefly in the Discussion. In particular, when should the median rather than the weighted average age be used for sea ice age characterizations? For what applications would the maximum, average, and modal age diagnostics and interpretations be appropriate?

Results

p. 10, line 7. It should perhaps be noted when comparing the NSIDC and SICCI products that the SIA produced by NSIDC assigns the age of the oldest particle to that cell (Maslanik et al., 2011). In addition, panels A and B in Figure 6 show that NSIDC forcing underestimates MYI extent in contrast to OSISAF forcing using the Lagrangian approach, in keeping with Szanyi et al. (2016).

p. 10, line 19. Perhaps include 'for OSISAF relative to NSIDC ice drift forcing' at the end of this sentence.

p. 12, line 2. Perhaps replace "speckles" with "discontinuities".

p. 12, line 14. 'SICCI SIA product' Is sea ice age defined according to the weighted product and consideration of SIC?

p. 12, line 20. "speckles" could be replaced with "discontinuities", as previously noted. Similarly throughout the manuscript.

p. 12, line 20. Perhaps highlight that lacuna and gaps in the sea ice age maps are associated with openings that are filled with FYI, as described on p. 3, and relate this to persistent artifacts in the NSIDC ice drift field associated with incorporation of buoy data. Panels depicting NSIDC sea ice drift fields for the indicated dates could be included in the first row of Figure 7.

Discussion and conclusions

p. 17, line 2. First statement. This is a key finding of the present study, and should be reiterated and included in the Abstract.

p. 17, line 14. 'Too low sampling…', as is also noted in Szanyi et al., 2016.

p. 17, line 18. 'The results show that…' Is the NSIDC or OSISAF ice drift data used for this analysis? It might be helpful to replicate these panels using the OSISAF dataset to determine whether similar patterns emerge with increased sampling using the Lagrangian approach.

p. 18, line 14. Differences in residence times may also be due to different ice drift products, in addition to differences associated with Lagrangian and Eulerian algorithms.

p. 19, line 11. Are undersampling issues not also a result of inconsistencies and persistent features in the NSIDC dataset?

The sea ice age product presented in the current study provides a novel alternative to existing sea ice age products through its spatial characterization of sea ice age distributions, with a number of potential applications, and implications for our understanding of relative changes in MYI and FYI in the Arctic.

Technical corrections

p. 1, line 17. Replace 'been focusing' with 'focused '.

p. 2, lines 8. Replace 'deform' with 'deformation'.

p. 4, line 1. Please clarify the phrase 'developed to apply on'.

p. 9, Figure 5 caption. The description for panels c) and d) should be reversed.

p. 10, line 4. 'DTU' Please clarify.

p. 12, line 26. Please change 'seem' to 'seems'.

p. 14, line 16. 'reasonless'. Please clarify. Perhaps this could be replaced with 'an inexplicable'?

p. 16, line 7. Please insert 'the' between 'reach' and 'coast'.

p. 18, line 14. Please replace 'that' with 'than'.

Reference

Rybak, O., and P. Huybrechts, 2003: A comparison of Eulerian and Lagrangian methods for dating in numerical ice-sheet models, *Annals of Glaciology*, 37.