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Interactive comment on "Open-source sea ice drift algorithm for Sentinel-1 SAR imagery using a combination of feature-tracking and pattern-matching" *by* Stefan Muckenhuber and Stein Sandven

Anonymous Referee #3

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Season's greetings to the editorial team, authors, and fellow reviewers.

The topic of "Open-source sea ice drift algorithm for Sentinel-1 SAR imagery using a combination of feature-tracking and pattern-matching" by Muckenhuber and Sandven (doi:10.5194/tc-2016-261) is obviously relevant for inclusion in The Cryosphere, and interesting to several of its readers.

This new manuscript extends upon the research presented in Muckenhuber et al. (2016), and introduces some new developments on a sea ice drift algorithm from Sentinel-1 SAR imagery for the "European" Arctic. Specifically, the authors present

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a pattern-matching step that is applied after the feature-matching step of Muckenhuber et al. (2016). Tuning of algorithm parameters, as well as a validation against a pool of ground-truth estimates is discussed (such a validation was missing from their previous paper).

A general impression after reviewing this manuscript is that it requires more work and provision of additional details before being ready for publication in TC. The authors are thus invited to revise their manuscript before a new version is submitted.

Specifically, the following items should be addressed:

1) Description of the algorithms

The “pattern-matching” step is not well enough described and many questions are still open at the end of section 3.2.

1.a) The ordering of the sub-sections (I. Feature-Tracking, II. Pattern-matching, III. Combination) is maybe not optimal as you spend some of Section III to describe the rotation by angle beta (that should really go into II). Maybe it would be easier to follow if the sub-section followed the steps of the algorithms (feature-matching, fitting of polynomial for first-guess, filtering, patter-matching, etc...).

1.b) It is unclear if your pattern-matching step features a series of x,y shifts to maximize the cross-correlation in addition to the rotation by beta, or not. If you combine both x, y, and beta shifts, what is the relative order and does it matter?

1.c) As you recall in I. “Feature-Tracking”, the ORB algorithms also gives an information about the rotation angle (delta between centroid-based orientation of the matched features). Is this feature-matching first-guess of the rotation used at all? If yes, how; and if no, why not?

1.d) What is “the initial rotation between the two Sentinel-1 image” (line 194) and how is it computed? Is it the same value across the image?

1.e) In subsection II. “Pattern-matching” you write the NCC formula for “two equally sized windows”. But later you seem to use two unequally sized windows (size t1 in SAR1, size t2 in SAR2). What is the NCC formula do you then use? Of is size t2 related to the size of the search window while t1 is the size of the pattern? The questions above are mostly to give an impression of the level of details expected when you re-formulate this section. Your first manuscript contained quite some details on the methodology, and this new one requires at least as many details.

2) Validation against GPS data.

2.a) The choice of validation metric (the distance between the end points of the reference and estimated vectors) is not peculiar. Virtually all other studies use the RMSE along two components (e.g. u and v). And the logarithmic distribution of the errors is not discussed or exploited. Please also discuss the RMSDs in u and v components and compare your results with that of other investigators.

2.b) The N-ICE campaign deployed many buoys, but very much in the vicinity of the vessel Lance. How many different buoys enter your validation database, and what is the average distance between them? Are we sampling more than few kilometres in each SAR pair?

2.c) N-ICE data should offer the possibility to discuss the accuracy when inside the pack versus at the marginal ice zone. Please see if you can segment your validation database to cover this. As you point out yourself, the added value of rotation should be most visible in the marginal ice zone.

2.d) Can you convince the reader (and the reviewer!) that the value of the maximum NCC indeed constitutes a quality measure (your Abstract)? Are matchups with lower NCC values really father away from GPS truth, than those with high NCC? Hollands et al. (2015) did not find any relation between the two. Is your threshold at 0.35 related to a significant drop in the documented accuracy against the buoy drift? (Hollands, T. , Linow, S. and Dierking, W. (2015): Reliability Measures for Sea Ice Motion Re-

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trieval From Synthetic Aperture Radar Images , IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 8 (1), pp. 67-75 . doi: 10.1109/JSTARS.2014.2340572)

2.e) You use a maximum velocity of 0.5 m/s for your feature-based results (line 171). Is this limit high-enough in view of your validation dataset in the Fram Strait region?

Finally, it would be good if the revision of the paper could include a thorough discussion of the robustness of the combined method to the success of the feature-matching step (not in terms of computation cost, but of introduction of artefacts).

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