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Interactive comment on "Comparing C- and L-band SAR images for sea ice motion estimation" *by* J. Lehtiranta et al.

Anonymous Referee #1

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This is an important study that should definitely be published. To my knowledge this is the first systematic comparison of sea ice tracking using almost simultaneously acquired C- and L-band SAR images. In this context, I like the description of the SAR images presented in section 3 focussing on the difference between C- and L-band for different ice conditions and ice types, and the implications for motion tracking. The paper is well structured. The text is not always easy to understand and requires improvements, see below.

My major criticism is the "Validation of motion estimates" for which the results of the operational algorithm by Karvonen are compared to the results of the algorithm developed for this study. Here, a couple of question arise: (1) Why was it necessary to implement another algorithm instead of using the existing operational one? (2) Why do

the results of the two algorithms shown in Fig. 14 differ so much? It is not true that both algorithms "produce the same large-scale southward movement successfully" as stated in the text page 2733, lines 16-17. If this comparison shall remain in the article, I think it is mandatory that you apply an ice mask to the operational results and discuss the differences relative to your own algorithm more in detail. (3) If you want to compare the performance of the tracking algorithm relative to a reference, you should manually generate a drift data set for selected image pairs. This would be most interesting for regions in which the difference between C-C, L-L, and C-L derived motion fields is largest.

Minor comments:

Abstract What do you mean by "seasonal sea ice inner structure"? I would not mention details about the processing (hardware acceleration) in the abstract.

Introduction Line 18: what do you mean by "empirical" data? Is it not "observations" in this context? Line 20: not all of the references that you list use the optical flow method. (I did not check in detail who does). Line 14: I would prefer if you give the wavelengths of the C- and L-band SARs that you use instead of the wavelength range to emphasize the actual difference

Data and methods Page 2724, line 2: "63th parallel" better use "north of 63°N latitude". Line 4: "baltic" -> Baltic Line 18: Do you refer to ice conditions occurring during the time when your satellite images were acquired? That's my conclusion from the following text. Please clarify. Page 2725: lines 13 and 15: replace "would be"-> were Line 16: . . .result WAS median-filtered. . . Lines 19-20: better: a size of 16 x 16 pixel was chosen

Section 2.3 Performance Here, I had most difficulties to understand all details. Page 2726: line 17: I am in severe doubt that it is possible to meaningfully evaluate the performance of a tracking algorithm relative to model simulations. Line 21: how is the "background" relative to the correlation peak determined? To which parameters does the regression coefficient refer?

Page 2727: in the first sentence it is mentioned that the derived ice drift fields are compared to the observed wind pattern. How do you do it? And in which section of the paper? Are the "two-highest-peak ratio" and the "median-raw" difference additional measures of the algorithm performance (besides peal-to-background-ratio, correlation peak magnitude, regression coefficient, difference between neighbors)? Which statistical properties of the ratio of the two highest correlation peaks do you use? I disagree that the median-filtered motion field represents the real average motion as it is stated in lines 7-8. It potentally represents a smoothed version of it (but real motion fields may include discontunuities). You consider a motion vector acceptable if it differs from the median-filtered value by less than 500 m - does this mean that you use the terms "displacement" and "motion" synonymously? When you use the 500 m displacement as a threshold, you refer to the displacement vector's magnitude. Do you consider the difference in direction between the raw and the median vector? I suggest to rewrite section 2.3 to make it easier to understand.

Page 2728, lines 14-16: Did the registration (= displacement) error vary spatially? In this case an interpolation between the land points is required, but were there sufficiently many spatially distributed land points available? Please clarify.

Section 3, Visual comparison between L- and C-band images It would be very helpful if you in the figures mark the areas you discuss in the text! E. g.where is Tornio? Which dark ovals do your refer to in Fig. 7? Where are the fainter floes, which you see in Fig 9, located in Fig. 2? page 2729, lines 18-22: The fact that the web-like features are stronger at L-band than at C-band does not necessarily mean that there are remnants of small ridges in the ice volume (in fact I never saw this in the field). It can simply be the fact that the number of strong reflections from ridges on the surface is less and the reflection patterns spatially less extended at C-band than at L-band (I found an image in an article by Dierking and Dall, TGRS 2007, Fig. 6 showing this).

Page 2732 line 14: you refer to the first row in Table 2. The two pairs you describe are listed in the first row of the upper and in the first row of the lower part in Table 2. Maybe

upper and lower part were meant to be printed as left and right column?

Page 2734, line 8: how is the "motion estimation error magnitude" determined? (Raw vector versus median as indicated in the figure? Please mention it in the text) Line 15: the reference to Fig. 14 is wrong. Do you mean Fig. 18?

Page 2735: line 8: "As a slightly surprising RESULT. . ." (why are you surprised?)

Conclusions: Page 2735, lines 13-15: "The program written for this purpose works and produces convincing results, so that the chosen algorithm of maximal cross-correlation suits this purpose." Was it one of your objectives to implement a new algorithm entirely based on cross-correlation (excluding phase-correlation)? What was the motivation for it? I did not find a convincing result showing the quality of the algorithm performance (see comment regarding Fig. 14).

Page 2736, line 9: "GPGPU" - printing mistake?

Reference list: I think that some important articles on the comparison between C- and L-band radar signatures of sea ice are not listed here. Please check and complement.

Figure 12: better write: "motion vectors from combining images 1 and 6. . .from the combination of image 1 and 5. . .(see also Figs. 13, 14)

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