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The Cryosphere Discussions

Interactive comment on "Towards a swath-to-swath sea-ice drift product for the Copernicus Imaging Microwave Radiometer mission" *by* Thomas Lavergne et al.

Anonymous Referee #2

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Summary

This paper presents an approach to calculate swath-to-swath (S2S) sea ice motion vectors from passive microwave imagery. Via comparisons with buoys, this approach is shown to be more accurate that the standard daily map products that composite brightness temperatures over a 24-hour period. The S2S are improved because the TB values are instantaneous instead of a "blurred" average and the time between images is exact as opposed an average time of all passes, which also "blurs" the motion estimates. The methodology is promising for the future CIMR mission, which will have wider swaths to obtain more motion vectors and higher spatial resolution for greater

accuracy.

General Comment

Swath-to-swath sea ice motion vectors has been a long-discussed idea, so it is great to see it successfully implemented here. The methodology is sound and it appears to be viable to do operationally. The paper is well-written and the results are convincing. I have a couple general comments. First, there is discussion of the packaging of the fields in Section 5, but it's still not totally clear how this would happen. I can understand the baseline approach, where there are fields for each of the overlaps and the times. But also discussed is the generation of daily maps. I agree that this would be useful and would probably be most convenient for most users. But it's not clear how this would be created. You would have motions for time periods of $\sim$100 minutes to over 24 hours. How would the different time separations be combined? The ice motion will vary between the periods, so simple interpolation/extrapolation may not work. The easiest thing would be to use the repeat orbit overlaps from each day – then there would be 24 hours between all vectors. But, of course, this leaves out many vectors. Maybe there could be some kind of weighting scheme to optimally combine vectors over different time intervals into an optimum cohesive daily map.

Another thing that came to mind while reading is the potential utility for summer motions. It's understandable to focus first on winter, but summer is not mentioned until Section 5. There are well-known limitations to using PM TBs for summer – most notably the surface melt and (especially for 89 GHz) greater water vapor levels. The S2S approach seems like it would be potentially quite helpful. First, the exact time of S2S will remove some error because ice is more dynamic in the summer, and potentially improve accuracy of the more sensitive lower frequency channels. For example, 18.7 GHz S2S may obtain better summer motions than daily composites. On the other hand, I wonder if the instantaneous S2S fields might cause some problems for the 89 GHz channels because water vapor can change rapidly and the "smearing" of the daily composite TBs may filter out some of that variability that could cause errors. It would

be great to have a summer example in the paper, but I think keeping the focus tighter on the winter case studies makes sense here. But I think some brief discussion of the limitations of PM for summer motions, e.g., in the Introduction, and a little more discussion in Section 5, would be helpful.

A few other minor comments are noted below. These are addressable in my view with minor revisions.

Specific Comments (by line number):

43: "short-lived" is ambiguous here. It may suggest something that lasts only a few weeks, but buoys can last at least a few years. That's short compared to long-term climate monitoring, but longer than what I would call "short-lived".

44: "scattered with vast distances between them" can be described more simply as "sparse". Perhaps rephrase this whole sentence to something more like: "Buoys have a limited lifespan before they exit out of the Arctic or the ice melts; this and limited opportunities for deployment result in sparse spatial coverage of the Arctic."

76-77: I don't see a reason to abbreviate "Section" here – it's more readable without the abbreviation.

81: Is there a specific citation recommended? At the least the website should be given, but if at all possible a formal citation (with date of access for a website) should be used.

Table 1: I would recommend giving the diameters of both dimensions of the sensor footprints, e.g., A x B, rather than the average. It provides better information and it looks like there is room to fit these in.

360-365: This would seem to argue towards using only (or primarily) the repeat orbits for the S2S instead of all overlaps, right? Or at least limiting to overlapping orbits that have orientations that limit the geo-location error effect?

405: I would note though that more advanced techniques, such as Backus-

Gilbert, do take account of the antenna pattern of the sensor and the measurement response function (MRF). So, it should be better than simple interpolation. Another approach that uses MRF for weighting is Brodzik et al., https://doi.org/10.5067/MEASURES/CRYOSPHERE/NSIDC-0630.001.

418: minor grammar suggestion, ". . .often leads to increases in the noise level."

Figure 9: Why does there appear to be more vectors on the Atlantic side of the Arctic than the Pacific side? I would expect the pattern to essentially be symmetric, but in the East Greenland, Barents, and Kara Seas, there are more vectors than at the same latitudes in the Beaufort, Chukchi, East Siberian, and Laptev Seas.

444: typo, ". . .larger than discussed here. . ."

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