General comments

The manuscript demonstrates a weekly sea ice drift product at 25 km resolution derived from SAR acquired by Sentinel-1 and Radarsat Constellation Mission (RCM). It is barely a scientific publication as no new methodology is suggested, no geophysical process is studied and as described below, usefulness of the new product is not well justified.

The idea of combining data from Sentinel-1 and RCM is brilliant, but it is very disappointing to read that 60.000 SAR images with resolution down to 20 meters were used to produce only weekly sea ice drift at only 25 km.

SAR imagery is a treasure for sea ice drift retrieval. Figure 6 clearly shows that in 90% of the Arctic a much more useful sub-daily product could have been generated. Table 2 clearly shows that 2.725.437 weekly vectors in the Central Arctic should not be averaged into a single matrix of 100x100 pixels. And with the input resolution of SAR data a product with spatial resolution of just few kilometers could easily be achieved.

With such high frequency and resolution, the new ice drift product would have become useful for studying highly dynamic processes (fault generation, instantaneous reaction to forcing, inertial oscillations), for detection and tracking of linear kinematic features and evolution of deformation, for validation of ice drift in ice models and for assimilation, for backtracking passive microwave observations for comparison with altimetry, etc. The authors took a very unfortunate decision to blend everything and generate a "consistent" product instead. Yes, the new product is "consistent" and yes, it contains few more ice drift vectors in areas with low concentration. But it doesn't make it more useful than the ice drift product from passive microwave which goes back to 1979. Weekly resolution can be useful for studying sea ice processes at time scales of forty years, but SAR will never achieve that. That's not the purpose of SAR. Obviously, an engineering decision to produce a "consistent" product took over a scientific rationale.

The formulation of uncertainty seems artificial and is not justified either. For example, why would uncertainty increase if the range of cross-correlation coefficients $(c_{max} - c)$ increases? Imagine two cells with all high c in one cell and all low c in another cell. The range $(c_{max} - c)$ is equal in both cells and sigma_SIM is also equal. But on the contrary, since cross-correlation coefficient represent vector quality (Page 18, line 401), I would imagine that the cell with low cross-correlation coefficients have higher uncertainty. The same skepticism can be applied to other components of the score alpha. The expected impact of t_{SAR} on uncertainty is not clear, whereas with more vectors the uncertainty should increase and not the opposite.

Combination of vectors instead of combination imagery from Sentinel-1 and RSN is not well justified either. The explanations regarding timeliness of S1 and RSN data arrival to the datacenter could hold for an operational product. But the presented product is not operational neither by definition (it is a weekly average), nor *de facto* – it is produced for 2020. Combination of SAR images from S1 and RCM into one stack would have at least doubled the number of image pairs for ice drift retrieval and allowed even higher frequency/density of vectors.

In my opinion the manuscript cannot be published in The Cryosphere without thorough analysis of the drawbacks of low resolution and the absence of combination of S1 and RCN imagery. Proper formulation and justification of the uncertainty should also be added.

Specific comments

Section 3.2

Lines 114 - 118

The reasoning for not mixing S1 and RCN imagery is weak and is not applicable here. The presented SIM product is not operational, and its production should not depend on arrival time of data. Ideally the processing chain should be changed to perform only individual preprocessing of S1 and RCN data in parallel branches and do the rest of processing in one stack of images. If that is not feasible, the impact of not combining imagery in a single stack should be clearly presented in the results and discussed. How many pairs of images is produced per week individually from S1 and RCN? How many pairs could have been produced if S1 and RCN data were stacked together? How much the resolution of the end product could have been enhanced? How was that computed?

Lines 175 – 180

What is a “consistent” product? This word has many meanings and should be well explained in the current scope. What is the advantage of having “consistent” product? What are the tradeoffs for generating a “consistent” product vs. a useful product? The following statistical analysis is needed for justifying “consistency”: relation between decrease in coverage and increase in frequency and resolution. For example, how much can we reduce temporal averaging step and spatial resolution to keep 90% of the Arctic covered by sufficient number of vectors in each cell?

Line 185

What is the impact of the threshold of 75 km/day? Where does it come from? Does it mean that vectors with 70 km/day are realistic? How many vectors are rejected? What is the impact of changing the threshold on overall accuracy and number of vectors?

Line 187

Why “median” is used for averaging? What is the statistical basis? Is it a normal distribution of ice motion within each cell? Should normalization be applied before averaging, so that mean can be calculated instead of median?

Section 3.3

Line 219 and Lines 229 – 234

Why is the fixed uncertainty used for both satellites? First, it was shown (Holland et al., 2011; Komarov and Barber, 2014; Korosov and Rampal, 2017) that uncertainty varies from sensor to sensor. Second, the uncertainty is higher for lower cross-correlations.

What are numerical and statistical justifications for the selected formulation of the uncertainty score? Uncertainty is a valuable parameter used, for example, for model evaluation and for assimilation. It should be realistic and reflect the actual spread of drift vectors within a cell. Authors possess vast observations of drift vectors and their RMSE within each cell. And RMSE within a cell is actually a measure of uncertainty. A statistical

analysis of the relationship between the proposed formulation of uncertainty and the actual RMSE should be performed. Such analysis should clearly show impact of each component of the score: *c*, *tau*, *n*.

Section 4.
Table 2.
The purpose of the table is not clear without some extra information. For example, it can help presenting the impact of changed resolution and frequency. The following columns should be present in the table to make it useful:

- Region
- Area
- Number of vectors per week (or per day)
- Number of pixels in the final product containing valid vectors at the following combinations:
    - 7 days, 25 km
    - 3 days, 12.5 km
    - 1 day, 6.25 km

It will hopefully show that even at the highest resolution the number of valid pixels is not dramatically small.

Figure 9.

- The vectors are not visible neither in the digital, not in the printed versions of the manuscript. Fewer vectors per inch should be shown and the figures should be rasterized with much higher resolution (at least 300 dpi).
- An example of ice drift in summer and in a shoulder-seasons should be presented. These seasons are especially challenging for ice motion retrieval from SAR.
- A line showing ice edge should be plotted to compare with the extent of the ice drift product.

Figure 10.

- Vectors are not visible here either.
- What is the source of patchiness in the drift map? Is it the discrete color scale that enhances gradients? Or is it because various patches were obtained from different image pairs and different sensors? Or is it natural? An explanation and a proof are needed, for example as an extra map showing source of data for each vector by color.

Section 4.2
Line 326
Due to the ambiguous nature of the alpha score in the uncertainty formulation it is impossible to associate high and low values of sigma_SIM with seasonal variations of sea ice physical characteristics. It could also be due to large range of cross-correlation coefficients, fewer image pairs, uneven distribution of images within a week. Since explicit interpretation of sigma_SIM is impossible the usefulness of the baseline values is not apparent either. As suggested above, the calculated uncertainty should be first related to the observed RMSE of vectors before its values can be interpreted.

Figure 14.
The maps with uncertainty look very heterogeneous and for the reasons mentioned above represent rather availability of data than actual uncertainty of the ice drift product. For example, one could expect overall higher uncertainty in summer and shoulder seasons (b and c) than in winter, but the range of values is equal to winter months. The uncertainty formulation should be revised to better reflect the actual spread of drift vectors within a cell.

Section 4.3
Line 356, 357
What is the purpose of averaging ice drift over a region prior to inter-comparison with OSI-SAF and NSIDC? Thousands of vectors are already averaged in a grid cell, so that spatio-temporal resolution of the tested and the reference products is matching. The intercomparison should therefore be performed on a cell-by-cell basis to better reflect the properties of the product on the resolution as close to the nominal resolution as possible.

Figure 16.
In addition to drift speed, comparison of drift direction should also be performed to form a complete picture of difference between the three products. It would also be desirable to plot a map of difference averaged, for example, over seasons.

Technical corrections

L20: OS**I**-SAF

L54: The word “perhaps” seems to need commas around

L54: “… combining of SAR imagery …” can be misinterpreted by a reader with a meaning “Images from S1 were combined with images from RCN to provide SIM vectors”. Rephrasing of the sentence is needed which clearly states that drift vectors from S1 and RCN were combined, and not imagery.

L141: What is “vertical scalability”? Some brief explanations (+ a reference) are needed.

L281: “3-day temporal resolution” contradicts the caption on Figure 12: “sea ice motion on August 12 – 18, 2020”. Which is correct?

L312: The sentence “For all cases, …” needs to be rephrased. Probably: “For all cases, low sigma_SIM values are typically found in the centra Arctic with gradual increase outwards…”

L324: “significant portion **of** marginal ice zone”