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Interactive comment on "Brief Communication: Mesoscale and submesoscale dynamics of marginal ice zone from sequential SAR observations" *by* Igor E. Kozlov et al.

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We would like to thank the Reviewer for his positive evaluation of the paper, constructive comments and helping us to improve the quality of the text by specifying many text edits that were fixed directly in the revised version of the manuscript. Below are our answers to the main points raised by the Reviewer:

"The paper title should preferably be modified to read: Mesoscale and submesoscale dynamics in the marginal ice zone from sequential SAR observations. The abstract is perhaps too brief. The importance for model validation should be mentioned in consistence with the Discussion and conclusion section."

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Discussion paper

Thank you for the comments. According to the Cryosphere journal rules, all short papers must be entitled starting with “Brief Communication: . . .”. We completely agree with changing of ‘of the MIZ’ to ‘in the MIZ’. Regarding the abstract length, it was made according to the journal rules for such paper types when the abstract is limited by 100 words only. These rules are specified at the journal homepage at https://www.the-cryosphere.net/about/manuscript_types.html. Nevertheless, we have managed to mention the ‘model validation’ in the abstract which now counts for 97 words.

“The submesoscale dynamics are also recognized to have intense, narrow bands of vertical motion. The authors need to address this issue in regard to the application of the MCC method whereby only the estimation of horizontal motion is discussed. For instance, could patterns evolve as influenced by the vertical motion, rather than the horizontal motion. The marginal ice zone is periodically also known to have bands of strong wind induced upwelling that would also influence the subsequent dynamics.”

Thank you for this important point. We agree, intense vertical motions associated with submesoscale dynamics may impact the evolution of sea ice patterns observed in the SAR images. This might either be due to upwelling of relatively warm subsurface water to the ocean-ice interface in the narrow surface current divergence zones resulting in gradual sea ice melt at the surface, or the surface water subduction in the current convergence zones that was well described e.g. by von Appen et al. (2018) in the study region from in situ sampling. In fact, this is something we have briefly mentioned in the introduction and addressed in more details when showing the horizontal divergence field in Fig. 3b. The latter clearly shows the formation of intense surface current convergence/divergence zones where sea ice accumulates/repel and the surface water goes down/up. In this sense, surface current retrieval using the MCC not only shows the regions of intense horizontal currents, but also the surface areas with intense vertical motions marked by high surface current divergence/convergence values. On the another hand, we might expect that the time interval between sequential

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Discussion paper

SAR acquisitions (around 1 hour) is perhaps too short to see the direct impact of the vertical motions on the evolution of sea ice signatures seen in the data. Do we correctly understand this comment or have missed something? Part of this answer is now included to the revised paper version.

“Moreover, the data are collected in September. This is related to the time of year of minimum sea ice extent and concentration. The summer sea ice melt is also nearing an end. Does this set up a shallow mixed layer regime in the MIZ that favors the presence of these mesoscale to submesoscale structures? If so, is there a seasonal variability to these SAR image expressions? It could be good to have this commented and/or addressed.”

Thanks for pointing this. Yes, we agree that our observations made in mid-September might have some specific seasonal features, like the mentioned formation of the shallow mixed layer favorable for the generation of such dynamic features in the MIZ. Yes, we do expect that there is a certain seasonal variability of such SAR image expressions. This is confirmed, for example, by results of our recent SAR-based study in the Western Arctic Ocean, where analysis of the data from June to October showed a clear peak in the number of MIZ eddies in September-October of 2007, 2011 and 2016. Moreover, Bondevik (2011) in her Master thesis also showed that SAR-based detections of MIZ eddies along the East Greenland Current throughout the years of 2008 and 2009 had a distinct seasonal variability with highest eddy numbers observed from May to September. In fact, we plan to address this question in more details for the Fram Strait MIZ in future by considering a longer time period of SAR observations. Some of the points mentioned above will be added to the revised paper version. We had a reference to Bondevik (2011) work in our initial paper version, but due to the limit of 20 references we had to exclude it. If the Reviewer feels it is necessary to have it, we will try to insert it.

“When Sentinel-1 is mentioned for the first time be more precise; e.g. Sentinel-1 is the European Radar Observatory for the Copernicus joint initiative of the European

Commission (EC) and the European Space Agency (ESA)."

Thank you for the comment. We had no space to accommodate for this info in the abstract, yet, have given the full description in the main text when Sentinel-1 was first mentioned.

"Line 128/129: This sentence should be improved. Avoid expressions like. . .its movement direction. . ."

We have changed this to ". . .its propagation direction. . .", however, we don't know if this has improved the overall sounding of the sentence.

"Line 163: . . .use same unit for EKE in text and Figure Maybe also color scale in the figure could be extended to identify values of 0.3 m2/s2".

Sorry, we couldn't get this as we have the same kinetic energy units expressed in the text and in the figure given in m2 s-2. Following your advice, we have adjusted the color scale to 0.25 m2/s2 , as this gives a better visual expression as compared to the initial 0.25 m2/s2 and suggested 0.3 m2/s2. We had also to add A, C1, F1, F2 notions and arrows to all subplots of Fig.3 according to the another reviewer suggestion.

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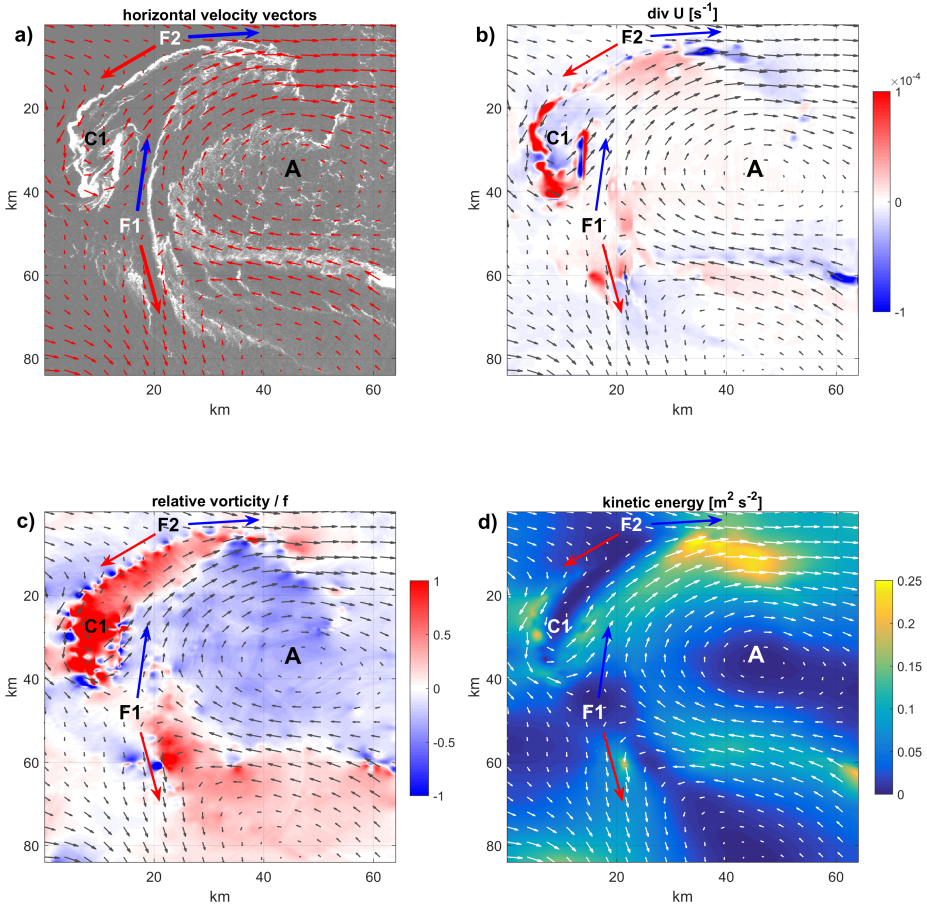
a)
horizontal velocity vectors
b)
div U [s-1]
c)
relative vorticity / f
d)
kinetic energy [m2 s-2]
F2
F1
C1
A
km
20
40
60
80
×10-4
1
0
-1
0.5
-0.5
0.25
0.2
0.15
0.1
0.05

Fig. 1.