

The Cryosphere Discuss., referee comment RC1  
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## Comment on tc-2021-85

Anonymous Referee #1

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Referee comment on "Sea ice and water classification on dual-polarized Sentinel-1 imagery during melting seasons" by Yu Zhang et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-85-RC1>, 2021

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Dear authors of the manuscript tc-2021-85,

In the manuscript a widely studied topic has been studied. The method is computationally quite heavy but the results in classification are good. The manuscript is quite thorough, the data set and the evaluation are quite comprehensive. There are still some aspects which need to be taken into account before publishing this manuscript. In the following are my comments.

Test and training data set: It is not very clear how the data has been divided into independent training and test data sets. Evaluation should be performed using a test data set which is independent of the training data set, i.e. the training data set must be excluded from the test data set. Now division into these two independent data sets is not very clear to me. Please, in detail describe the division to independent training and test (evaluation) data sets to confirm the reader that they are independent.

Introduction:

Also sea ice concentration (SIC) estimates can be and are derived based on the proposed SI/OW classification scheme. I recommend to include missing references to SAR-based SIC estimation, there are many papers on this published during the recent years, e.g.:

Wang, L., K. A. Scott, L. Xu, D. A. Clausi, Sea ice concentration estimation during melt from dual-pol SAR scenes using deep convolutional neural networks: A case study, *IEEE Trans. Geosci. Remote Sens.*, vol. 54, no. 8, pp. 4524–4533, 2016.

Wang, Scott, Clausi, Sea Ice Concentration Estimation during Freeze-Up from SAR Imagery Using a Convolutional Neural Network Remote Sens. 2017, 9(5), 408; <https://doi.org/10.3390/rs9050408>

W. Aldenhoff, A. Berg and L. E. B. Eriksson, "Sea ice concentration estimation from Sentinel-1 Synthetic Aperture Radar images over the Fram Strait," 2016 IEEE International Geoscience and Remote Sensing Symposium (IGARSS), 2016, pp. 7675-7677, doi: 10.1109/IGARSS.2016.7731001.

Karvonen, Evaluation of the operational SAR based Baltic Sea ice concentration products, Advances in Space Research 56(1), 2015, DOI: 10.1016/j.asr.2015.03.039

And some references combining microwave radiometer and SAR for SIC estimation:

Karvonen, J., Baltic Sea Ice Concentration Estimation Using SENTINEL-1 SAR and AMSR2 Microwave Radiometer Data, IEEE Transactions on Geoscience and Remote Sensing (Volume: 55, Issue: 5, May 2017), pp. 2871-2883, 2017, DOI: 10.1109/TGRS.2017.2655567.

Malmgren-Hansen, D., Pedersen, L. T., Nielsen, A. A., Brandt Kreiner, M., Saldo, R., Skriver, H., Lavelle, J., Buus-Hinkler, J., Harnvig, K., A Convolutional Neural Network Architecture for Sentinel-1 and AMSR2 Data Fusion. IEEE Transactions on Geoscience and Remote Sensing, v. 59, n. 3, pp. 1890-1902. 2021, <https://doi.org/10.1109/TGRS.2020.3004539>

Especially convolutional neural networks in sea ice classification and parameter estimation have gained popularity during the recent years. These methods are computationally heavy but software for their parallel efficient execution on graphics adapters exist.

P3 L34: "...sea ice deformation features shows much more textural that decrease the severability between flat thin ice and calm water." I don't understand this sentence. Please, rewrite this.

P4 2.1 Research area:

The sentence "To consider the spatial contextual information and preserve the spatial

details

of each pixel in SAR imagery, the energy function based maximum a posteriori (MAP) estimation

in MSTA-CRF framework is proposed for operational ice water classification during melting seasons in Fram Strait." does not belong to this subsection, it could be in introduction or methodology section rather. Just start the section by "This study was performed in the area of Fram Strait during the melting season." or something similar.

P4 L21: "Figure 1 shows an overview of the research area and some satellite scenes used in this manuscript." and Figure 1 / Figure 1 caption.

Why just some scenes are shown? Could the figure for example show the total amount images at each location of the study area (by using some color coding), it would be much more informative.

P5 Sentinel-1 SAR Data:

L6: "... data during melting seasons from 2015 to 2020 are used.". Please, be more specific,

give the periods. Is the melting period the same every winter? E.g. some kind of temperature

statistics from nearby weather stations to confirm that the data represents melting period every winter would be useful here.

P6 Methodology:

Figure 2. If I have understood correctly SPAN image is used as an input? Now in the figure there is an arrow from the leftmost SAR processing block to the MSTA-CRF block and it looks like

the uppermost row SAR data were input to the MSTA-CRF, possibly the arrow could be started from

the lower part of the block as is the second arrow. Assuming I have understood this correctly.

P5 L5: SPAN of the HH and HV channels ( $\sqrt{\text{HH}^2 + \text{HV}^2}$ ). Later SPAN is defined as square root

of  $\sigma_0_{\text{HH}}^2 + \sigma_0_{\text{HV}}^2$ . Possibly the square root could be dropped from here and just say

that SPAN represent the joint total power of the two SAR channels and leave the more precise definition later.

P7 L16: There is wrong year in the publication, it should be 2017, not 2018.

There also exist this publication:

Park, Won, Korosov, Babiker, Miranda,

Textural Noise Correction for Sentinel-1 TOPSAR Cross-Polarization Channel Images, IEEE Transactions on Geoscience and Remote Sensing ( Volume: 57, Issue: 6, June 2019),

DOI: 10.1109/TGRS.2018.2889381

Please, add the reference and check which version of the python SW have been used in this study.

P9 L8: "In corrected HV, backscatter coefficients of thin ice are greatly reduced."  
This sentence is difficult (at least for me) to understand, Please, reformulate.

P9 L13: "Figure 5 (e)", You probably mean Figure 4 (e)?

P9 L18 "for each category", as there are only two categories it would be better to say "for both categories".

P9 L19: "using the MET Norway ice charts". Please, be more specific and describe exactly how the ice charts have been utilized.

P10 L2: "each categories" -> "both categories"

P10 L10: "...that when the training samples reaches..."? Do you mean "...that when the number of training samples reaches..."?

P10 L32: "...contains a great number of scatters of radiation..." -> "...contains a large number of scatterers of radiation..."

P11 Table 3 caption: "...probability density function (pdf)..." -> "...probability density function (PDF)..."  
or rather even "...probability density function..." and give the acronym PDF in the text.

P11 L12: "PDF" -> "probability density function (PDF)", PDF always with capital letters.

P11 L22 and Eq. 8: Explain what is M (is it number of PDF's here?).

P12 L6: "...into several sub-superpixel using a random number..."? What does this mean?  
"...into several sub-superpixel using a random number of pixels..."?

P12 Eq. 9: What are K and N in the equation?

P12 "... $y_i$  and  $y_j$  are the SAR backscatter coefficients at a pair of subsuperpixel..."? Are these really SAR  $\sigma_0$  values or SPAN values?

P13 23: "CV (coefficient of variance)"? Do You mean "coefficient of variation"? At least for me coefficient of variance is an unknown concept. If You use it, please, define it.

P14 Fig. 6: Add x-axis labels ("model number" or something describing what is on the x-axis).

P14 Fig. 6: Be more specific in Y-axis label, now there is just "normalized". "normalized" what? I guess "normalized parameter" would be better here. Fig. 6a is not very clear with so many curves in one figure. Would there be any alternatives to make a more clear image (or more than one image)?

P15 L17-18: "PDF (probability density function)" This has already been opened on p. 11, so just write "PDF".

There seem to be some sentences which are not very easy to understand. I am not a native English speaker and may not have noticed all of these sentences or possible grammar or typing errors.

I recommend to let a native English speaker (Your co-author Nick Hughes) to check the sentences and language of the revised manuscript before submission.

Sincerely,