

Interactive comment on “Accuracy and Inter-Analyst Agreement of Visually Estimated Sea Ice Concentrations in Canadian Ice Service Ice Charts” by Angela Cheng et al.

Anonymous Referee #3

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General Comments: This paper presents a good overview of the importance of ice charts for not only navigation guidance, but as a relevant archive for climate monitoring and use as a validation variable. This is a very nice paper that provides some good and novel approaches to evaluate how to provide some level of uncertainty in ice charts, particularly with the Kappa statistic and Krippendorff's alpha applications. Additionally, this is hopefully the start of a trend in producing much needed literature that focuses on the role of ice charts in research and development for environmental monitoring. This includes the challenges with how different data sources should be handled and the variation between information input, including the subjective nature of ice analysts. This topic has always been of great interest to the research community that depend

C1

on ice charts as a source for validation and to provide initial conditions in models. With the onset of large volumes of data and predicted increased activity in the Arctic, the ice services are preparing for an integration of automated operational products to assist them in providing accurate information for end-users. For this reason, it is crucial that papers focusing on this topic can clearly communicate 1) why this is important in the operational sense, 2) fundamental challenges in automating sea ice information for operations (which has been going on for the last 30 years) and 3) apply metrics relevant to evaluate automated techniques to the level that can be useful for operations. This paper touches on these three points and opens up more opportunities to explore this topic further in future research.

There are some overall suggestions that would be good to include which would improve the paper. The geophysical limitations with monitoring different sea ice types and concentration relative to the season was mentioned in the conclusion but should be stated earlier in the paper because this is one of the main challenges in sea ice automation. There was no mention of the difference of automation with passive microwave and SAR and seasonal/ regional limitations. Often this has been confused in the research community and should be clear that both sensors will be limited by the same environmental conditions (i.e. wind (noise) and melt). This will help to clarify the sentence in P3 L29 regarding the melt season caveat.

Specific Comments: Title: Should reflect that this comparison is only a case study using HH polarization in SAR. The current title and the inclusion of passive microwave suggests automation is being applied to various sensors and polarizations. Current classification applications that ice services are evaluating are primarily focused on dual-pol SAR and experimenting with full polarimetry as well.

P2 L3 By stating the analysts visually segment the pixels suggests there is some sort of segmentation application applied here. I am assuming this is referring to how analysts make the decision on where ice and open water is located in the image? If so, state that the ice analyst is able to determine these areas and manually delineates them with

C2

polygons. Then you can omit the statement "(this segmentation is not drawn)".

P2 L6 Here would be a good place to refer to the ice chart manual, MANICE, put out by CIS or the WMO . You can add that reference after this sentence. Please review: <https://www.ec.gc.ca/glaces-ice/?lang=En&n=2CE448E2-1&offset=8&toc=show>

P2 L28 It would be good to provide a sentence or two on why automating ice information has been a challenge for ice services in the past. We are using the same types of sensors that have been available since passive microwave has been available and with the beginning of the use of SAR in the 1990's. Ice services continue to rely on manually drawn charts because automation for sea ice has significant limitations at the marginal ice zone, coastlines, first year ice types and ice edges for spring and summer sea ice, where we see the greatest amount of traffic in the Arctic.

P3 L20-25: Would be good to include when CIS started to use SAR and the amount of SAR vs PMR that is currently used today. From the understanding in ice services, CIS charts primarily consist of SAR and other high resolution data and only use PMR sparingly because it is unable to detect sea ice features and coastal zones well.

P3 L30-31 Should provide a statement that the current state of automation for ice services will rely on the two channels (dual-pol) until a compact polarimetry is available. Therefore, would be good to provide an explanation as to why was HH only used in this study when the HH/HV has been available with RS2 since 2007.

P4 Figure 1 is misplaced in the manuscript and should be located after its mention in the text.

P4 L2-6 Include reference to MANICE manual and also the Dedrick paper (K.R. Dedrick, K. Partington, M. Van Woert, C.A. Bertoia & D. Benner (2001) U.S. National/Naval Ice Center Digital Sea Ice Data and Climatology, Canadian Journal of Remote Sensing, 27:5, 457-475, DOI: 10.1080/07038992.2001.10854887).

P4 L9 Include reference to WMO manuals 259: JCOMM Expert Team on Sea Ice

C3

(2009) WMO Sea-ice Nomenclature, WMO/OMM/ĐŠĐIJĐđ - No.259 Suppl.No.5. Linguistic equivalents. Geneva, Switzerland, JCOMM Expert Team on Sea Ice, 23pp. (WMO No, 259, Suppl. 5). <http://hdl.handle.net/11329/113>.

P5 L11 What does "greatest intersectiong overlap" refer to? Please provide a more clear explanation.

P5 L12-16 Where is the comparison done for the Wilcoxon-Mann-Whitney test? Is this a general comparison that had been done before with ice charts or is the image analysis referring to the new polygon generated by an analyst for comparison? Also, and what is "image analysis" referring to? Is this automated image analysis. It appears that you are referring to a previous comparison that had been conducted because you specify the new polygons in this study in the following sentence in P5 L13.

P5 L25-27 Already stated in previous section that only HH is used in this study. Should instead provide reasoning as to why only HH is used when it is first mentioned in P3 L30-31. Again, why is HH only used? You state to "ensure that differences in ice concentration estimates between individuals were restricted to only interpretation of the segmentation, rather than interpretations of the multiple polarizations normally available," however, how does the interpretation of only using one polarization differ from multiple polarzations regarding introducing any bias in the analyst interpretation?

P7 L3-4 We should assume the analyst understands the user interface before doing the assessment. Unless there is something that could be shown with these two polygons that demonstrated the analysts understood the user interface, this disclaimer does not need to be here.

P7 L15-16 One of the major challenges with automating products for operational ice charts are due to the large differences of surface appearances based on regional and seasonal variability. It was noted in the abstract and conclusion but since this is a common problem it would be better to state it in the beginning paragraphs or something that provides information on how monitoring sea ice in these areas vary with respect

C4

to region (fast ice vs. drifting ice) and season, particularly with the melt and Summer season. It will help the reader to have context as to its difficulty and why this data hasn't previously been automated for ice services. Additionally, a table listing the images and dates should be included somewhere so that the reader can get an idea of the types of ice conditions that were being assessed in this study.

P19 L1-6 This paragraph describes the types of images and criteria that were selected for this study. The description of the area selection with regards to the contrast and floe size would be best placed in section 3.1 in order to help set the stage for the study. This section in the conclusion can reiterate and summarize this again and continue to expand on it more detail as you have in the later part of the paragraph.

Technical Comments: P5 L9 "...polygons created by the analyst were compared to the corresponding areas from the published operational charts that used the same Radarsat images."

P5 L11 "The uncertainty of the corresponding coordinate of the polygons show an uneven distribution between one another..."

P13 L4 "The first objective of this study was to compare analyst..."

P13 L6-7 The sentence "Segmentation is not necessarily...." is a very strong statement and could be refuted in some ways without any resources to provide support. You can replace it with something that describes it similar to the following justification: Segmentation papers tend to explore very limited samples of satellite data which they do very well but there are not many papers that apply the same types of techniques across a wider spatial and temporal scales. Whereas ice charts have been produced on a consistent basis for more than 40 years by a wide range of different agencies. Though we know there are differences among ice charts, they overall agree where and what types of ice are present within a given area, with small variations.

P14 L2 Replace "...ranged.." with "...the accepted segmentation results varied be-

C5

tween analysts."

P14 L3 Rephrase to state "In 36.8% of total polygons, the analysts were unanimous in agreement with the outcome of the automatic segmentation."

P15 L1-3 "An overall agreement between analyst estimation and segmentation results are shown along the diagonal line, where the proximity of entries outside the line represent the extent to which analysts are over or underestimating ice concentration (Figure 7). There was an overestimation of ice concentration from the analysts with respect to MAGIC.

P15 L4-6 The first sentence is redundant and could flow with the following sentence by combining them and not repeating the same results to state: "Over-estimation of low ice concentrations (i.e. 2/10 to 4/10) resulted in an increase in the number of polygons with high ice concentration (9/10 to 10/10)."

P15 L7-8 Delete "In the cases where some analysts accepted the segmentation results, while others did not, we only considered the responses where it was valid." Already stated in the first sentence in L7.

P15 L9 Delete the parentheses because this is an individual sentence: "Figure 10 shows the combined responses from all participants in this study. (Individual responses are shown in Figure 11)."

P17 L27 Sentence does not need to be put in parentheses.

Figures: Misplaced throughout the manuscript and should be more closely aligned with the text throughout the document. They should be placed after the mention in the text rather than before, or after subsequent figure references.

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2019-190>, 2019.

C6