

Interactive comment on “IcePAC – a Probabilistic Tool to Study Sea Ice Spatiotemporal Dynamic: Application to the Hudson Bay area, Northeastern Canada” by Charles Gignac et al.

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ICEPAC – A PROBABILISTIC TOOL TO STUDY SEA ICE SPATIOTEMPORAL DYNAMIC: APPLICATION TO THE HUDSON BAY

Reviewer #5, We thank you very much for your valuable and helpful comments on our work. We made interesting discoveries about the behaviour of our model by adding the Hall Beach site which showed a different sea ice spatiotemporal evolution pattern from the other sites. We made all suggested modifications to our manuscript. Thank you for the time invested in our manuscript. CG

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R = Reviewer comments A = Author response and B = manuscript modifications

A modified version of the manuscript is found as supplementary file.

MAJOR COMMENTS

R: “I think the author needs to provide some more context on the Hudson Bay ice cover, discuss the limitations of passive microwave datasets and directly discuss where this tool could be applicable.”

A: We added the information and modified the manuscript as suggested.

B: Information on the Hudson Bay sea ice cover, the choice of passive microwave and discussion about potential applications of the tool has been added in the Introduction. As for the limitations of passive microwave imagery, a paragraph was added in the Data and Methods/Sea Ice Concentration dataset section lines 154 to 180

R: “Several papers have now highlighted trends toward earlier breakup, later freeze-up and a longer open water season within the HBS. Provided the timing of these seasonal changes is an integral part of the IcePAC tool they should be discussed.”

A: Done.

B: Information on trends regarding ice season duration have been added on lines 97 to 115.

R: “The OSI-430 dataset needs to be introduced and contrasted from the OSI-409 dataset.”

A: Done.

B: Information on the OSI-430 dataset has been added to the Data and Methods/Sea Ice Concentration dataset section, lines 149 to 152.

R: “This would be a good place to compare the known differences between SIC derived from passive microwave sensors and the CIS charts.”

A: Done. We gave the information to make sure that the limitations, especially during summer and fall were brought forward for the readers.

B: A short paragraph outlining the divergences of passive microwave estimated SIE (extent) versus the CIS maps estimated SIE has been added on lines 176 to 180. A reference to Agnew and Howell (2003) was added.

R: “In terms of coastal and offshore comparison sites, why did you choose these 6 locations?”

A: These locations were selected for their difference in latitude, their expected sea ice spatiotemporal variability and their respective specificities such as the expected stability for the Central Hudson Bay point (OCHB), the interest of the shipping community for Churchill (OC) and Iqaluit (OFB), the known polynya at Cape Dorset (OCD). We thought using these specific sites would make it possible to outline the different scenarios of spatiotemporal dynamic one could expect in such a complex sea ice environment.

As for the OFB point, we originally considered it as part of the HBS, though we understand that the limits of the Hudson Strait are considered to be at the southwest point of Frobisher Bay. Nonetheless, we did keep the OFB point as it outlined that, even if the result obtained by the model are obviously erroneous, it is not due to the approach but clearly to the data source.

B: Nevertheless, following reviewers comments about those locations, we added two comparison sites in the revised version of this manuscript: Offshore Northern Ungava Bay (ONUB) at the entrance of the Hudson Strait and Coastal Hall Beach (CHB) in the northwestern part of Foxe Basin. The ONUB location was selected because of its strategic position in the navigation corridor in the Hudson Strait while the CHB location was added to represent the particular ice regime in the Foxe Basin.

MINOR COMMENTS

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R: Remove “Northeastern Canada” from title.

A: Done

B: “Northeastern Canada” was removed from the title.

R: The term meltdown is used instead of melt throughout the paper.

A: Corrected.

B: Terminology has been modified throughout the manuscript.

R: “Sea ice dynamics” implies sea ice ridging, rafting, transport, motion, etc. Another wording has to be used to refer to the variability in spatiotemporal patterns of sea ice.

A: Terminology has been modified in the text to make sure there will be no confusion.

B: Now, we are using “sea ice spatiotemporal pattern” or behavior.

R: Elaborate and provide references on the statement “Given the increase in activity noticed in the Arctic. . .”

A: Done.

B: Expected causes of increasing activities in the Arctic where listed from line 46 to 48 and 3 references added to the manuscript.

R: “This is an oversimplification of the CIS. The ice atlas does provide climatological conditions but weekly ice charts are available and do provide more detailed information.”

A: More detailed explanation on the different ice products available from CIS, such as the weekly and daily maps, ice concentration and development stage maps as well as reports has been added to the text.

B: These information were added in the Introduction, lines 54 to 64.

R: “A complete freeze-up in late December. An annual maximum extent is usually

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achieved in April. . .” Once the HBS is completely frozen over, the spatial extent of sea ice can no longer increase. This needs to be revised.

A: We agree.

B: The text was modified (lines 89 to 93) to clearly differentiate the period where the freeze-up made most of the HBS ice covered in December versus the actual sea ice maximum extent in April. R: “How are the three different states defined?”

A: As you suggested, this part of the text was removed as it brought no pertinent information to the following analyses.

R: “When discussing the variations in and out of the predicted range of SICs, the three factors listed should be discussed in the introduction or methods. There is notable natural variation in SIC within the HBS; this should be discussed in the introduction. What are highly improbable events in the ice cover?”

A: We agree and made sure more information and details were provided to the readers concerning this matter. Note that Figure 6 was modified as suggested by many reviewers.

B: We did add a discussion about the natural variation of sea ice conditions in the HBS in part 2 – Description of the HBS, lines 97 to 105. The expression “highly improbable events” was removed from the text, but it simply referred to events with very low probabilities of occurrence.

R: “To compare the PMW derived IcePAC tool with the CIS there needs to be a more through discussion of the ice charts.”

A: We do agree with you that a comment on the ice charts was lacking in the manuscript.

B: We added information on lines 415 to 430 regarding the regional ice charts used for building the CIS 1981-2010 atlas. We outlined the main differences between the two

dataset, so the readers could interpret the results adequately.

A: “It would be suitable in the conclusions to include a statement about the applicability of this tool to marine transportation or coastal engineering as a predictive tool.”

A: We did add information regarding possible applications of IcePAC to engineering, fauna protection, navigation in the Conclusion.

B: We added the information in the Conclusion lines 494 to 496.

FIGURES AND TABLES

- All maps have been rotated so the north is upward. - Hall Beach has been included in our list of coastal communities and maps have been adjusted accordingly. - Hall Beach was added to the ice free season length analyses; therefore, it was included on Figure 9, as suggested. - Figure 3 was removed as, like you suggested, it didn't bring relevant information for the reader. - Figure 4 has been modified to reflect the importance of trend removal as it ensures spatial continuity in IcePAC results. - Figure 5 (queries flowchart) has been modified according to your suggestion. - Figure 6 was entirely modified. - Figure 9 was modified given your suggestions. Hall Beach was added to the analysis. - Table 1 was referred in the text.

Please also note the supplement to this comment:

<https://www.the-cryosphere-discuss.net/tc-2018-178/tc-2018-178-AC5-supplement.pdf>

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2018-178>, 2018.

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