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The Cryosphere Discussions

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 #3, We thank you very much for your valuable and helpful comments on our work. As suggested, more details were added regarding the importance of the trend in our procedure. Many sentences and words were rephrased in order to improve the overall quality and comprehensibility of the manuscript. All maps orientations were modified as suggested. CG

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

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

GENERAL COMMENTS

R: "My main question/concern is the effect of trends on the effectiveness of the tool. The authors note that the trend must be subtracted for the stationarity condition to be met, which is necessary for the frequency modeling approach. However, it seems to me the trend is quite relevant in terms of using the method as a forecast tool. If there is a trend towards a longer ice-free period (as there is in the Hudson Bay region), it seems a forecast that doesn't account for that, will gradually become less and less effective? Perhaps I'm missing something here. I can understand that frequency modeling requires removal of the trend, but does that make such a method less effective in an environment with a strong trend? I think bit more discussion on this would be helpful."

A: You are right to say that the model cannot render significant predictions without taking into account the trend. Maybe it wasn't correctly explained in the previous version of the paper that, even though the distribution model fit is made on detrended data (pure SIC% signal) the information on the trend is kept and reused during model queries to generate valid results. As such, we can say that the trend is "managed" in IcePAC.

B: To make sure readers understood this essential information, we added a paragraph describing the way the trend is managed in IcePAC in section "3.2.3 Trend Estimation and Removal" (lines 233 to 243). We also modified the Figure 5 (the model flowchart) in which we indicate where the trend is either removed or reinjected into the results depending on the query made.

R: "In the discussion on the CIS analyses, I think it's important that other potential limitations of these are that (1) their input data are not always consistent, (2) they use human interpretation of imagery. These mean that the analyses are somewhat

subjective and may be inconsistent. For CIS, they've been using SAR for the Canadian region, so consistency is less of an issue than perhaps for other ice services, but still worth noting I think."

A: We agree with your comment.

B: Some details were added regarding the ice charts production at CIS in the "Introduction" but mostly in section "4.2 Comparison with the Canadian Ice Service Atlas".

R: "You say complete freeze-up happens in late December, but then say the annual maximum is usually achieved in April. But isn't the maximum reached when complete freeze-up occurs? I think you mean that complete freeze-up happens in late December and the HBS remains fully frozen through April."

A: We agree with your comment.

B: This sentence was reformulated to make things clearer (line 89 to 93).

R: "meltdown is driven from the shores to the center of the bay. . . – this isn't quite true though. As shown in Figure 8, the SW Ontario shore is the latest to melt out, so it's more of a NE to SW melt out pattern, right?"

A: Figure 8 (IcePAC outputs), as well as CIS analysis, show that sea ice starts melting along the east and west shores of the Hudson Bay and gradually melt toward the center part of the Bay, culminating in the end, to a final melt in the south central part of the Bay, in front of Winisk (as explained in Figure 9). If the ice melt started only from the east coast of the Hudson Bay, we would have agreed to say that it was a NE to SW pattern but since the melt gradually evolves from both sides of the Bay, we've kept our formulation as it was in the previous version.

R: "Also, I'd say "the predefined area is commonly represented by a pixel. (As a nit-picky thing, for data fields, I think "grid cell" is better than "pixel", which technically refers to an image, but I guess this is a matter of personal taste.)"

A: For the "pixel" versus "grid cell" terminology, other reviewers have also brought that point.

B: Terminology was modified accordingly.

R: "OSI-430 is simply a near-real-time version of OSI-409, isn't it? The algorithm is the same and the input data is very similar. So, I don't think it qualifies as an independent data source."

A: The sentence was modified to simply clarify the fact that OSI-430 wasn't used as an input to estimate the parameters of the distribution models.

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

R: "sea ice dynamics". You don't mean "dynamics" in terms of dynamical forcing of ice motion, do you? I think you mean something more like "regime". But I'm not sure. If it's not related to forcing or motion, then you shouldn't use "dynamics" here.

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

B: Now we are using the expression "sea ice spatiotemporal pattern" or behavior.

R: The anomaly maps from NSIDC are actually part of the NSIDC Sea Ice Index (though they're used on the News and Analysis website). Suggest referencing the Sea Ice Index, https://nsidc.org/data/seaice_index/. Fetterer, F., K. Knowles, W. Meier, M. Savoie, and A. K. Windnagel. 2017, updated daily. Sea Ice Index, Version 3. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. doi: https://doi.org/10.7265/N5K072F8.

A: This was added to our references list.

R: I don't totally understand what Figure 6 is showing. I think it needs more explanation, either in the text and/or in the caption

A: Other reviewers suggested that Figure 6 should be modified to be easier to interpret. A new version of the Figure was then produced and therefore our discussion links to Figure 6 was slightly modified.

B: Explanations were provided in the text from line 323 to 351.

R: As I was reading this, I was wondering about land-spillover. It's good that it's noted, but I think it deserves more discussion. Readers may not understand what land spillover is. And it's not clear what the impact is on your results. With a relatively small area and a lot of coastline, I can see where it may have an impact. Of course, much of the effect is filtered out (which should also be mentioned), but whatever remains may have an impact.

A: Relevant information on the impact of land spillover, its definition and corrections mechanisms applied in the OSI-409 and OSI-430 products was added in section "3.1 Sea ice concentration dataset". As it turns out, the error at the OFB point was linked with an error in the NSIDC monthly climatological mask of sea ice extent used in the OSI-409 algorithm. The mask was indicating that, during all summer months, there is a possibility that sea ice would be present in Frobisher Bay (an identical situation appears in Roes Welcome Sound). Therefore, the OSI-409 algorithm was processed in the area and was affected by the land spillover effect as there was absolutely no ice in the Bay.

B: Explanations on the errors occurring in the IcePAC results were added on lines 346 to 351. More details on the land-spillover and its correction in OSI-409 were added from line 160 to 167.

R: Speaking of "dynamics" (as noted above), I wonder what the effect of motion will be on your statistics. You use "first week" to define melt-out and freeze-up, which is fine. But it is possible to have a pixel melt-out and then ice drift into the cell from a neighboring pixel; and similarly, could have a pixel freeze-up and then advect away, leaving open water again. I imagine this effect is small, but it's worth noting that the ice

is not necessarily static.

A: The effect of ice motion on our statistics is expected to be very small as we work with 30+ year time series for each grid cell and that they are weekly averages of 7 daily SIC% maps. As ice motion can be fast, especially for drifting ice during melt-out, we don't suspect such a phenomenon has an effect on our statistics. Also, considering the 12.5 km grid cell, the drifting ice floes would have to be numerous or very large to have an effect on the statistics.

R: Maybe adding a figure (earlier in the paper, e.g., between Figures 3 and 4) showing an extent time series for the HBS and the trend would be helpful. This would show the magnitude of the trend and suggest the impacts of its removal.

A: The original figure 3 was replaced by a figure presenting a time series for a costal site of the HBS on week 50 (i.e. freeze-up), its detected trend and the impact on the time series.

B: We have made a new figure 3 that presents such a series.

R: Should note that the maps made by trained analysts are made from remote sensing imagery. This could also be noted earlier when the CIS analyses are first mentioned.

A: We agree and made modifications according to your comment.

B: The information was added to the manuscript from line 59 to 61.

Please also note the supplement to this comment:
https://www.the-cryosphere-discuss.net/tc-2018-178/tc-2018-178-AC3-supplement.pdf

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