

## ***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.***

### **Anonymous Referee #3**

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**Summary:** This paper presents an application of a frequency modeling statistical tool to investigate probabilistic behavior of sea ice in the Hudson Bay region. Freeze-up and melt probabilities can be calculated for different regions, providing a range of likelihoods for various communities. The statistics compare well with Canadian Ice Service analyses.

**Comment:** The method presented is interesting and shows promise as practical tool to aid community planning and forecasting. The method appears generally sound and is well explained. The comparisons with the CIS charts are a good validation.

My main question/concern is the effect of trends on the effectiveness of the tool. The

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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.

Another general comment is that while the paper is overall well-written, there are some awkward words or phrases that are probably due to non-native English-language writers. I've noted some of these below, but a good proofread by a fluent English language writer would be helpful.

Specific Comments, by line number:

47-52: 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.

56: "HBS" hasn't yet been defined. In Line 58, it becomes clear what HBS, though it isn't explicitly noted.

78-79: I wonder why this orientation of the map is chosen. It's much more common to have the orientation rotated 90 degrees to the right – i.e., North to the top, as it is in the inset. And either way, it would be good to have both the main map and the inset with the same orientation. The figure is roughly square, so it shouldn't be a problem to rotate the figure (and adjust the associated annotation appropriately) to the more familiar "north is up" orientation.

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73-74: 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.

75: "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?

89-96: Some references are needed here – i.e., line 90, what "recent research"?

101: Add "e.g.," before Shokr and Sinha, 2015. Many other references have used the same definition of concentration and it was originated long before 2015. 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.)

142: Here is the issue with the trend, as discussed above.

202: It's stated later, but it would be good to be clear here that the 20,738 points refers to the number of pixels (grid cells) in the HBS domain.

226: 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 a "an independent data source".

227-228: I don't understand what this sentence means: "The comparison was made..."

229: "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.

242: The anomaly maps from NSIDC are actually part of the NSIDC Sea Ice In-

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dex (though they're used on the News and Analysis website). Suggest referencing the Sea Ice Index, [https://nsidc.org/data/seaice\\_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>.

245: 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.

252: 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.

275-277: 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.

278: Likewise, as above, add "e.g.," before the references. Several references are given, but the 15% threshold is widespread, so the list is not comprehensive.

292-207: Here is where I wonder what effect the trends may have? Maybe it's not critical (at least at this point), but it seems like it would be. Maybe adding a figure (earlier in the paper, e.g., between Figures 3 and 4) showing an extent timeseries for the HBS and the trend would be helpful. This would show the magnitude of the trend and suggest the impacts of its removal.

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320: 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.

Minor Comments (grammar, language, etc.), by line number:

19: “Results were” 20: “meltdown” is not correct; I think “melt-out” or simply “ice-free” are better 23: “information” instead of “informative” 29: “rise” or “increase”, not “raise” 30: “conclude” instead of “apprehend” 32: “capital” is a bit too much; suggest “key” instead 45: “observed” instead of “noticed” 101: “a SIC dataset” 110, 112: “uses only” instead of “integrates” 113: “using the Natural Earth...” 188: “yielded a” instead of “brought” 189: “cases” instead of “time” 192: “in light” instead of “in scope” 210: space after “#1” 233: “interval” instead of “pace” 257: remove “confirms” 291: “noting” instead of “to note” 291, 292: do you mean “deduced” instead of “deducted”? 313: “studied” or “analyzed” instead of “under scrutiny”

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

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