

Review for tc-2022-137 "Changes in the annual sea ice freeze-thaw cycle in the Arctic Ocean from 2001 to 2018" written by Lin et al..

The timing of melt onset , freeze onset and melt duration in Arctic plays a key role in the evolution of sea ice, and are important variables for understanding the Arctic climate system. "Changes in the annual sea ice freeze-thaw cycle in the Arctic Ocean from 2001 to 2018" written by Lin et al. studied the melt onset, freeze onset at the ice surface and at the ice bottom in the Beaufort Gyre and in the central Arctic Ocean from 2001-2018 using multi-source data, including sea ice autonomous observations from mass balance buoys (IMBs), moored upward looking sonar (ULS), and Ice-Tethered Profilers (ITP), and remote sensing data from passive microwave and reanalysis data from ECMWF ERA5. This manuscript is generally well written, and the methodologies are proper for getting results in the manuscript. I suggest to publish the manuscript after minor revisions as listed below.

L32, add "," before "play a key role"

L37, L39, Please check if the references are cited properly.

L53, Add references for the statement in L50-53.

L54, "step" or "step-like"?

L64, can remove "due to freezing" after "basal ice growth".

L80, move "freezing and thawing processes" before "sea ice surface"-

L81, It seems that "Another method" appears very sudden. For this, L66-80 can be listed as a separate paragraph. In addition, please rewrite the sentences of L66-68 , for example, " The sea ice freeze-thaw cycle can be identified using the data measured by sea ice mass balance buoys (IMBs), which consist of a thermometer chain in combination with ... (Perovich et al. 2021). "

L110-114, rewrite the sentences to more concise, e.g., "The IMBs deployed on landfast ice are excluded because shallow coastal waters have ... (Eicken et al., 2005)".

L116, "The surface melt and freeze onsets is related to observations of near surface air temperature collected by the IMB" or "The surface melt and freeze onsets is related to the near surface air temperature", Please rewrite this sentence.

L144-146, If the 17 ITPs deployed in the central BG include the 12 ITPs used for detecting the basal melt or freeze?

L179, remove "of the" at the beginning of this line.

L223, Can you list the four pairs of surface melt and freeze onsets and one pair of basal melt and growth onsets in the list to make them more clear for the readers?

L226-228, It is better to clearly note 2014. Such as, "In 2014, ESMO-PMW was on 02 May, triggered by a spring storm event, and was about ...SMO-IMB. Apart from that, the 2014 CSMO-PMW, SMO-SAT and SMO-IMB dovetail ....."

L233, add "2014 before "SMO-IMB", and before "ESMO-PMW".

L235, add "2015" before "SMO-IMB", and "2014" before "SFO-IMB".

L240, Figure 2. The legends for "ESFO-PMW, CSFO-PMW" in 2014 were wrong. Please correct them.

L255, remove "ensured" after "before fully freezing".

L257, For 13d delay after the SAT decreases below freezing, do you mean SFO-SAT?

L260, remove "defined as".L265, Figure 3 seems not clear. Please redraw it.

Explain “-” and “+” in the tables.

“median” should be “moderate”, please correct it.

L273, please check BFO lagged SFO by almost three or two months?

L276, confuse about “a decreasing trend of surface and basal melt onset” and “increasing trend of freeze onsets”. Do you mean “surface and basal melt onsets later and freeze onsets earlier with an increase of latitude” or “surface and melt onsets are decreasing and the freeze onsets are increasing with the increase of latitude? Please rewrite.

L285, The meaning of “YD” in figure 4. For easy understanding, it is better to use date and month, e.g., 11 June, also in the figure, not Julian Day. Similar for Figure 8, and Figure 11.

L310, Please refer Table 2 in the text. The average surface net radiation changes were calculated using ERA5 reanalysis data. Please add this information to the Table 2.

L312-313, Difficult to understand this sentence, please rewrite it.

L314-315, “almost twice as large”, compare to which?

L324-329, The trigger of SMO is an increase of longwave radiation (L300-301), and the key to BMO is when  $F_w$  becomes greater than  $F_c$  (L322). Thus the explanation in this paragraph only can explain why the BMO in the BG occurred much earlier than the BMO in the CAO, but cannot explain why the BMO in the BG much earlier than the SMO, while they occurred almost at the same time in the CAO.

L346, change “,” to “;” between two references.

L347-348, can be more clear or concise as “jointly resulted in the time of BFO later approximately 3 months than SFO.”.

L361, "plays the opposite role of a thermal insulator" seems wrong. Please rewrite it.

L375, "Figure 5" should be "Figure 6".

L382, refer Table 4 in the text. The meaning of  $\Delta H_i(m)$  in the Table?

L388, use different symbols for the surface and ice melt, to discriminate the symbols used in Eq. (5).

L396, remove "had "

L408, the meaning of (2.14m), (0.77m), (0.22m) ?

L410, what does the "intital" mean in "the initial ice thickness"? It means the ice thickness when the IMB installed, or the ice thickness when the SMO commences?

L412-413, Figure 6 indicate the linear relationship between ICI and BFO-SFO, which didn't consider the ice concentration. Thus this statement cannot related to Figure 6 as stated "relative to the linear regression as shown in Figure 6".

L421, add "Thus" before "The average annual ice thickness" to connect this sentence with the previous one.

L432, the caption of (d) and the figure ylabel is not same. Please correct the wrong one.

L435, Shoud "Figure 3c and 3d" be "Figure 4c and 4d"? recheck.

L443-444, The positive feedback between thinner and more vulneralbe ice and eariler BMO is a general statement. How can you derive this feedback from L435-443 where you talked about the decal changes of BMO and the average oceanic mixed layer temperture depature from the local freezing point.

L453: I don't agree "the IMB observations do not catch the freezing and thawing of the seasonal sea ice". This is also paradoxical your method for detecting SMO, SFO, BMO and BFO from IMB observations.

L468, "by the two methods" or "by the two moorings"? From the text, it seems that you mean "by the two moorings".

L480: Can remove BGOS-C: cyan since have excluded this mooring.

L498-499, Difficult to understand this sentence, please rewrite it.