We authors thank you for your time and constructive comments on the manuscript "Changes in the annual sea ice freeze-thaw cycle in the Arctic Ocean from 2001 to 2018". We would consider each comment carefully and incorporate practically all of them.

L37, L39, Please check if the references are cited properly.
Reply: We check the references, and consider them as proper citations.

L53, Add references for the statement in L50-53.
Reply: we will add the reference for the statement with (Persson, 2012).

L54, "step" or "step-like"?
Reply: We will change the "step" to "step-like".

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 thermitor chain in combination with … (Perovich et al. 2021)."
Reply: Thank you for your comments, which makes the context more logical. We will revise as your suggestion.

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)".
Reply: We will revise as your suggestion.

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.
Reply: Agree. "collect by the IMB" need to be deleted.

L144-146, If the 17 ITPs deployed in the central BG include the 12 ITPs used for detecting the basal melt or freeze?
Reply: The 17 ITPs deployed in the central BG was listed in the figure 9a, and the 12 ITPs used for detecting the basal melt or freeze were listed in Table 3. 7 of 12 ITPs used for detecting the basal melt or freeze were in BG, which were included in the 17 ITPs. And the rest of 5 ITP in CAO were not.

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?
Reply: The four pairs of surface melt and freeze onsets and one pair of basal melt and

growth onsets have been listed in the supplement, due to their large space.

Reply: Yes. the time when SAT decreases below freezing equals to SFO-SAT. The sentence will be rewritten as "… , with an average delay of 13 days after SFO-SAT."

Reply: We will delete "defined as" and revised from "median" to "moderate". The "-" and "+" in tables is the time difference of column minus row, which will be state in the caption of table.

Reply: The average SFO was on 20 August, and the average BFO was on 14 November. The BFO was 86 days lagged behind SFO, which is almost three months.

Reply: To make the expression more clearer, the sentence will be rewritten as "The overall spatial patterns revealed that the surface and basal melt onsets were decreasing and the freeze onsets were increasing with the increase of latitude, as one would expect.".

Reply: For easy understanding, we will modify the time in figure 4, figure 8, and figure 11, i.ie., using "MM/DD" instead of "YD", as well as throughout of the manuscript.

Reply: The reference of Table 2 will be added, as well as the information in the title.

Reply: we compare the average ΔT, u_{*0}, F_w, and F_c between the time period of 10 days before BMO and 10 days after BMO using data of 12 ITPs, this sentence will be rewritten to make it easy for understanding.

Reply: We will rewrite the sentence as "… almost twice as large as ΔT (–10 d),…"

L324-329, The trigger of SMO is an increase of longwave radiation (L300-301), and the key to BMO is when Fw becomes greater than Fc (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.
Reply: The SMO and BMO depend on the heat budget of ice surface and base, respectively. In addition to the larger amount of incoming solar radiation based on latitudes, the larger fraction of leads also results in more absorption of solar radiation. The last sentence in this paragraph used "may" and "partly" as a speculation.

L347-348, can be more clear or concise as "jointly resulted in the time of BFO later approximately 3 months than SFO.".
Reply: it will be revised as your suggestion, which make the expression more clear.

L361, "plays the opposite role of a thermal insulator" seems wrong. Please rewrite it.
Reply: The snow cover insulate the conductive heat transfer due to its lower thermal diffusivity. So thicker snow depth plays the opposite role when compared with lower surface air temperature. we will rewrite the sentence as "… plays the opposite role as a thermal insulator…".

L382, refer Table 4 in the text. The meaning of ΔHi(m) in the Table?
Reply: Table 4 will be referred in the text and the column of ΔHi(m) could be deleted.

L388, use different symbols for the surface and ice melt, to discrimate the symbols used in Eq. (5).
Reply: We will change H_i and H_s to ΔH_i and ΔH_s according to another reviewer's comment.

L408, the meaning of (2.14m), (0.77m), (0.22m) ?
Reply: These numbers show the exact total basal melt.

L410, what does the "initital" mean in "the initial ice thickness"? It means the ice thickness when the IMB installed, or the ice thickness when the SMO commences?
Reply: Here, the "initial" in "initial ice thickness" means the time when surface melt begin. So, the initial ice thickness is the ice thickness when the SMO commences. We will specify this in the text.

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".
Reply: We will delete this inappropriate sentence.

L443-444, The positive feedback between thinner and more vulnerable ice and earlier 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 temperature departure from the local freezing point.

Reply: The changes of temperature departure from the local freezing point in May derived from ITP observation reveals that the surface ocean is warmed earlier than the past, which mainly attributed to solar absorption through opening leads. Thus, there is a positive feedback between thinner and more vulnerable ice and earlier BMO. We will add the impact of opening leads on the changes of oceanic mixed layer temperature.

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.

Reply: The key point of this sentence is the "seasonal sea ice", since the majority of IMB were deployed on the multiyear ice. That is the reason why we also used the ULS data to represent the seasonal sea ice.

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

Reply: The two methods mean two data sources, i.e., IMB and ULS. So we will revise to "…from IMB and ULS…".

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

Reply: It should be the "earlier basal growth onset" instead of "earlier basal growth". We will rewrite the sentence.

L32, add "," before "play a key role"
L64, can remove "due to freezing" after "basal ice growth".
L80, move "freezing and thawing processes" before "sea ice surface"-
L179, remove "of the" at the beginning of this line.
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".
L346, change "," to ";" between two references.
L375, "Figure 5" should be "Figure 6".
L396, remove "had"
L421, add "Thus" before "The average annual ice thickness" to connect this sentence

Reply: All the grammatical mistakes and inappropriate expressions will be revised as your suggestion.