Response to RC4

We express our sincere appreciation for the time and valuable feedback provided by the reviewer on the manuscript titled "Impacts of anomalies in Arctic sea ice outflow on sea ice in the Barents and Greenland Seas during the winter-to-summer seasons of 2020". All comments will be carefully reviewed, and we are committed to incorporating the suggested changes to ensure that our manuscript is significantly enhanced.

General comments:

1. What is the reason to choose these two atmospheric circulation patterns for assessing the effects of large-scale atmospheric circulation on the changes in Arctic sea ice outflow? I would suggest that the authors also look at whether there is an abnormal North Atlantic Oscillation in 2020, and if so, the influence of the North Atlantic Oscillation on Arctic sea ice outflow should be discussed.

Reply: Thanks for the suggestion. Based on previous literature (Kwok, 2009; Vihma et al., 2012), the main atmospheric circulation patterns that have an impact on Arctic sea ice outflow are Arctic Oscillation (AO), North Atlantic Oscillation (NAO), and Central Arctic west-east air pressure gradient Index (CAI). we chose AO and CAI mainly because we found that they showed obvious positive anomalies in the winter (JFM) and spring (AMJ) of 2020, with positive values ranking high in the period 1979-2020 (Table 1), while NAO did not show such strong anomalies in 2020. Certainly, the impact of NAO on the Barents and Greenland Seas (BGS) cannot be ignored, and we will quantify the correlation between NAO and sea ice conditions in the BGS and add a corresponding discussion.

References:

Kwok, R.: Outflow of Arctic ocean sea ice into the Greenland and Barents Seas: 1979–2007, J. Clim., 22(9), 2438–2457, https://doi.org/10.1175/2008jcli2819.1, 2009.

Vihma, T., Tisler, P., and Uotila, P.: Atmospheric forcing on the drift of Arctic sea ice in 1989–2009, Geophys. Res. Lett., 39(2), https://doi.org/10.1029/2011gl050118, 2012.

2. Section 3.3 focus on the comparison of the reconstructed sea ice backward trajectories in 2020 with the 1988-2020 climatology. The comparison assumes that the reconstructed sea ice backward trajectories are convincing. However the validation of the reconstructed backward trajectory method is not sufficient. I would suggest that the authors provide more assessments on the validity of the reconstructed trajectories using buoy observations.

Reply: To give credibility to our sea ice backward trajectory reconstruction results, we plan to use observed buoy data for validation, such as MOSAiC buoy data and buoy observations from IABP (International Arctic Buoy Programme). We will evaluate the

effectiveness of the reconstructed sea ice backward trajectory considering the case where AO and CAI are in the positive or negative phase.

3. Section 3.4 discussed the anomalies of the sea ice area and thickness in the Barents and Greenland Seas. The data analysis on sea ice area is relatively adequate. However the analysis of sea ice thickness anomalies is mostly qualitative. I would suggest that the authors provide more quantitative results on sea ice thickness anomalies and discuss them in details.

Reply: Thank you for the suggestion. We will provide a quantitative analysis of sea ice thickness anomalies in the BGS and further discuss them based on the data results.

4. If the abnormal Arctic Oscillation and Arctic sea ice outflow do not occur in winter, but in other seasons, will the effect be different for the ice and marine environment conditions in the Barents and Greenland Seas? It would be better to add more discussion on this.

Reply: Following your suggestion, we will add a discussion on the impact of summer AO anomalies on the BGS, since generally, sea ice motion responds more strongly to the atmosphere in summer. We plan to quantify sea ice area flux (SIAF) through Fram Strait and sea ice conditions in the BGS using years with positive summer AO anomalies during 2010-2020, to explore the impact of summer AO anomalies on sea ice and marine environment conditions in the BGS.

5. It is a last resort to use different sea ice thickness products (radar altimeter and PIOMAS model-based data) in different seasons. My concern is whether using different data produces inconsistent results. For example, during the freeze-up period, whether there is deviation or even contradiction between the qualitative conclusion and quantitative results using PIOMAS model-based data and radar altimeter?

Reply: This is a good point. We will calculate the results of sea ice thickness (SIT) anomalies for both SIT products in the BGS during the freezing period and compare whether there is a large discrepancy between SIT anomalies obtained from these two products during the same period. And we will add sentences to assess the consistency of the two datasets and whether there is an impact on the relevant conclusions.

Specially comments:

1. Line 72, change “during winter-spring 2020” to specific month, since you do not define the range of winter and spring months before that.

Reply: We will revise this sentence to clarify the specific months to which winter and spring refer.

2. Line120-122, “We regridded the monthly SIT data on the 25-km EASE-Grid to maintain consistency with the CryoSat-2/SMOS SIT data.” These two datasets also have different temporal resolutions. How was this difference addressed in your study?
Reply: We obtained the same temporal resolution as the PIOMAS SIT data by monthly averaging the weekly CryoSat-2/SMOS SIT data. We will add a description of how to harmonize the temporal resolution in the SIT data section.

3. Line 161, change "restructured" to "reconstructed" to unify the expression and apply to the entire manuscript.
Reply: We will check the entire manuscript and revise this inappropriate expression.

4. Line 271, “enhanced sea ice meridional motion”, remove the “meridional”, since you do not directly calculate the meridional sea ice motion speed.
Reply: We will remove the “meridional” as you suggested.

5. Line 294, The text on the right side of Figure 5 is too busy and not intuitive enough. It is preferable to express the trend of sea ice area graphically.
Reply: Thanks for the suggestion, we will use charts to depict the trends of the sea ice area for a more intuitive understanding.

6. Line 319, “The anomalies in cumulative surface heat fluxes from January to June 2020 can be related to a reduced decrease of 0.01–0.41 m in SIT, estimated using the Eq. 4” This is ambiguous. Does cumulative mean cumulative over time or across net surface heat fluxes?
Reply: In fact, it refers to the accumulation of the entire net surface heat fluxes containing surface heat fluxes of sensible heat, latent heat, net longwave radiation, and net shortwave radiation. We will revise the sentence to clarify the meaning.

7. Line 327, change the y-axis title in Figure 7 to “Surface heat fluxes anomaly”, because it is surface heat fluxes anomaly instead of surface heat fluxes in the figure caption.
Reply: We will revise the y-axis title for clarity.

8. Line 377-378, “In addition, we examined the statistical relationship between the April SIA and the monthly SST with a lag of 1–3 months in the BGS (Table A4).” Is this correlation for the detrended SIA and SST? This comment applies to the entire manuscript.
Reply: In our manuscript, the correlation results are all correlations between the detrended variables. We will add notes to make them clear.

9. Line 388, “The Chl-a over the southern Greenland Sea in April 2020 was smaller compared to the previous 5 years.” Give the latitudinal range of the southern Greenland Sea.

Reply: Thanks for the reminder. Our revised manuscript will specify the latitude range over the southern Greenland Sea.

10. Line 389, “A significant negative correlation between Chl-a and SIA in April over 1998–2020 was identified”. The geographical scope of this sentence is unclear. Is there a negative correlation between Chl-a and SIA in the BGS or only in the Greenland/Barents Sea?

Reply: The negative correlation between Chl-a and SIA is significant only in the southern Greenland Sea, and we will revise this sentence to clarify the meaning.

11. Some illustrations need to be further revised, for example, the definition of the study area in Figure 1 is not so normative.

Reply: Thanks for the suggestion. We will revise the definition of the study area in Figure 1 to make it reasonable and normalized. Accordingly, we will update the analysis results associated with it.