

Review of paper by Haibo Bi et al., “Contributions of advection and melting processes to the decline in sea ice in the Pacific sector of the Arctic Ocean,” submitted for publication to *The Cryosphere*. This is a solid but not a groundbreaking study. I recommend for publication with minor revisions.

Page 1, line 13 and elsewhere: Say “Pacific-Arctic sector of the Arctic Ocean” as in your title, not “Pacific-Arctic Ocean:” the latter does not exist. Same for “Atlantic-Arctic Ocean.” A major comment is the suggestion that you strive for consistency in your text and graphics. IE: a) consistent units: i) Abstract uses 10^3 km^2 for PA \rightarrow AA outflow, and 10^6 km^2 for melting. Just use 10^6 km^2 for all, so that a reader can clearly compare eg 0.173 vs 1.66. ii) /yr vs /a: Sometimes you use “per year” and sometimes you use “per annum” and sometimes you do this in the same sentence! Just pick one and always use this. iii) /de vs /yr: I don’t know if /de is a standard way to write “per decade” but in any case you mostly use /yr (or /a) so I suggest you translate the /de to /yr or /a. b) consistent terminology: Is the distance along your flux gate (2840 km) the WIDTH or the LENGTH? Sometimes you use one, sometimes the other. I think it should be the length; the width is 25 km ie the grid size, yes? c) consistent graphics scales: Figures 2 and 8: Use same vertical scale for left and right panels

Response: a) consistent units are used in the revised manuscript. i) we use 10^6 km^2 for outflow and melting sea ice area. ii) we use /yr throughout the paper. iii) for the trends where ‘/de’ is used, we change them to ‘/yr’. b) Following the suggestion, we keep using LENGTH for the distance spanned by the fluxgate. The grid size is 25 km. c) the vertical scale for the left and right panels in Figures 2 and 8 are changed to a consistent scale. The figures are redraw accordingly.

Page 2, line 27: You could also include this reference for faster ice and changing drag, internal stress: Zhang et al. (*GRL*, 39, doi:10.1029/2012GL053545, 2012)

Response: this is an excellent reference and we add it (P3, L1 in the revised version of the manuscript with a edit-tracking format). Hereafter, without specific statement, the page and line numbers denote those appear in the revision with a edit-tracking format.

Page 2, line 31: There are a number of model studies that have considered dynamic vs thermodynamic forcings separately. One example is Figure 9 in Lindsay et al. (*J. Clim.*, 22, doi: 10.1175/2008JCLI2521, 2009).

Response: We carefully read this paper and found Lindsay’s work is very interesting and of great relevance to our study. The paper is noted in the revised manuscript (P3, L5-6).

Page 3, lines 15-16: Just say “NSIDC.” It is “University of Colorado” not Colorado University, but NSIDC is enough.

Response: Corrected as suggested.

Page 3, lines 23-24: Please provide a reference for these unrealistic buoy velocities. Are you referring here to Szanyi et al. (*Geophys. Res. Lett.*, 43, doi:10.1002/2016GL069799, 2016)?

Response: The reference is presented in the revision (P4, L3-4).

Figure 1: a) Please give the lat/lon coordinates of each endpoint of the flux gate line. b)

There is no need for the compass rose, and in fact it is inappropriate on a map with the North Pole included. c) Is there a southern boundary of the PA? maybe at Bering Strait? This should be noted with a blue line, just like for the southern AA boundaries.

Response: a) the lat/lon coordinates of the endpoints of the fluxgate line are presented (see P5, L3-4). b) the compass rose is removed since it is not useful on a map with the North Pole. c) the southern boundary of PA is provided in the revised Figure, as marked with blue lines near the Bering Strait and Banks Island.

Equation 1: The units of F are length²/time, yes? Please note this here.

Response: the unit of F is km²/day and we note it in the text.

Table 1: Please provide the units for ice area flux. Also, it's "length" not width, I think (see comment above on consistency.)

Response: The units for sea ice area flux is provided and the "length" is used.

Page 5, line 17: Your English is generally quite good, but there are numerous minor errors in spelling and grammar. EG here it is "annual" not "annul."

Response: The manuscript is thoroughly read and examined by each author trying to avoid errors in spelling and grammar.

Bottom of page 5: Is it possible to provide a better estimate of the error in your calculations from the neglect of ice deformation (eg from numerical model studies)? Further, this error should be noted in the rest of your paper. EG if you find that there is a trend in total melt in the PA of X%, but this is smaller than the error from neglect of deformation, then do you have a significant result? Please discuss.

Response: At this point, we do not have a better estimate for the deformation contribution to sea ice loss. However, Lindsay et al(2009) provided an estimate due to deformation, which causes approximately 1% of sea ice area variation within the Atlantic side of the Arctic Ocean. Since the Pacific sector is dominated by ice divergence process, the sea ice coverage loss due to convergence may be less than that of the Atlantic sector. Thereby, we use 1% as a upper limit in sea ice changes due to deformation in the Pacific side, which is fairly less than the trend in total melt sea ice in PA (3.2%/yr for the period 1979-2016).

Page 6, lines 10-11: Is this DA index publicly available? Could you provide a link? AGU journals require a discussion of data availability; The Cryosphere may not, but it is all of our responsibility to discuss data availability so that our results can be independently reproduced.

Response: The DA index is not publicly available but a reference is provided (Wu et al., 2005). For the DA index data from 1979-present, it is kindly provided by Wu Bingyi through E-mail (bywu@fudan.edu.cn.).

Page 6, line 14: "precipitable"

Response: Corrected as suggested.

Figure 3: It is not immediately obvious to me that there is more blue on the left and more red on the right. Some nice further analysis is provided in subsequent plots, but for this one, I might suggest the addition of the annual mean anomaly on a new bottom row, which could more clearly summarize the trend.

Response: the addition of the annual mean anomaly is shown in the bottom row.

Page 9, line 2: This is very interesting. Any thoughts on why the extremes are not

changing?

Response: Despite the extremes are not changing overall, we further identify that the extreme low anomalies ($A \leq -1$) reduce from 20.8% in P1 to 10.4%, while the extreme high anomalies ($A > 1$) increases from 7.5% to 16.6%. This shift in sea ice exchanges between the PA and the AA sectors may indicate a shift of atmospheric circulation toward a pattern facilitating sea ice export out of the PA side (Wu et al., 2005; Zhang et al., 2008; Jia et al., 2009). (Please see P10, L13-15).

Figure 8: Use same vertical scale for both panels. Note that the line goes from N. America (left) to Eurasia (right).

Response: the same vertical scale is used for both panels in the revised manuscript. Also, following the suggestion, the endpoint location of the lines is given in the caption of Figure 8. (see P14, L2-4)

Figure 9: It is nearly impossible for me to see these panels clearly and thus to interpret this figure. Could you try to make a better one, maybe with fewer panels?

Response: For a clear demonstration, we selected fewer panels with five-year estimates in each decade since 1980s being presented. Additionally, legend is given for easy identification of sea ice area changes due to advection or melting processes.

Page 13, lines 6-9: Are you saying that melting in the AA is of similar magnitude to that in the PA, but that the AA ice is getting replenished by PA ice? This would be a major new result if true. But I kind of doubt that it is true, given that the AA is (in the mean) farther north than the PA, and so probably there is more melt in the PA.

Response: We do not expect to express the idea that melting in AA has a similar magnitude as that in the PA, which is not real. The regarding sentences are rewritten or removed to avoid this misunderstanding. A notice is added to show that AA in higher latitudes is likely less subject to melting than that in PA. (see P14, L11-14)

Section 4 Discussion re climate indices: The Arctic community went through a phase in which everything was correlated with climate indices. This fad has faded as ice continues to decline independently of climate indices. Further, climate indices don't provide predictive skill. It is unclear to me what they do provide, specifically in the present context of this paper. I might suggest that you write some introductory words to this section that explain why you are correlating your results with these indices, and then at the end, what your significant correlations provide in terms of new insight.

Response: The explanatory words are presented in the first paragraph of Section 4 and a summary of the new quantitative findings is given in the last paragraph. In brief, wind forcing has been significant in modulating the sea ice variability in summer. The Arctic-wide wind forcing is linked to large-scale atmospheric circulation patterns. Hence, the connection between the sea ice area loss in the PA sector and three typical atmospheric indices (AO, NAO, and DA) are assessed here. The temporal changes of the correlation among different decades (Table 4) provides us the new evidence of a shifting atmospheric regime in the Arctic.