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Interactive comment on "Contributions of advection and melting processes to the decline in sea ice in the Pacific sector of the Arctic Ocean" *by* Haibo Bi et al.

Anonymous Referee #1

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Review of "Contributions of advection and melting processes to the decline in sea ice in the Pacific sector of the Arctic Ocean" by Bi et al.

Summary

This paper presents an analysis of changes in sea ice in the Pacific sector of the Arctic. It notes the significant downward trend and delineates between advection and thermodynamic components. The decline is correlated to Arctic climate oscillations – the AO, NAO, and PDO. The strongest relationship is found with the DA, with a weaker correlation for the NAO, and the weakest for the AO. The NAO primarily is linked with thermodynamic processes (melting), while the DA link is strongest for advection, but is

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also strong for melting.

General Comment

This is a nice paper that updates previous analyses of sea ice changes in the Pacific sector and the contributions of melt/growth and advection processes. The paper is well-written and thorough. The methodology appears sound and is explained well and the results are clearly presented. There are a few small questions/concerns, noted below. After addressing these, I find the paper acceptable after minor revisions.

Specific Comments (by page and line number):

P2, L4: “de” is non-standard and somewhat confusing for “decade”. I would use either “dec”, “d”, or “decade”.

P2, L11: what is the NSIDC report? Need to reference (if it’s a webpage, I think it’s fine to just include the link)

P2, L15: Could provide a more updated reference than Maslanik et al., (2011): Tschudi et al., Remote Sensing, 2016

P3, L17: Should provide the full citation (and include in the reference list) for the data, not just the website. NSIDC provides guidance on proper citation on their product website.

P3, L17: Note that a new version of the product will soon be released. At this point, I wouldn’t expect your analysis to be redone and I don’t think the new version would substantively change your results, but noting so that it is addressed in the final paper. Also, there is a new reference, submitted to The Cryosphere, documenting the changes:

Tschudi, M. A., Meier, W. N., and Stewart, J. S.: An enhancement to sea ice motion and age products, The Cryosphere Discuss., https://doi.org/10.5194/tc-2019-40, in review, 2019.

P3, L18-19: The first letters in the SSM/I, SSMIS, and AMSR-E written out sensor

names should be capitalized. P3, L22-23: There are a couple erroneous statements here. The SIM product is on the EASE-Grid, which is an equal-area projection – it is not polar stereographic. Also, some AVHRR images were removed due to errors, but AVHRR sources are still used for the 1979-2000 period. Likewise, a few buoys were removed, but buoys are used throughout the product. Maybe there just needs to be a rewording of the sentence to be clear.

P3, L27: As for the SIM, the full citation should be provided for the SIC product. NSIDC provides guidance on proper citation on their product website.

P4, L4-5: Again, an error here in the grid/projection info. The SIC is on a polar stereographic grid, but it is not equal area. I assume that this is just a miswording. However, if an equal area is assumed for the polar stereographic grid, that will give incorrect sea ice extent and area estimates. Each cell in the polar stereographic grid has a different area, so when summing for extent, you have to account for the specific area of each cell. If this was not done, then I would say that the analysis needs to be redone. NSIDC provides grid cell area files for the polar stereographic grids.

P5, L3: I can understand the focus on the summer, but it's important to note that the quality of both the SIC and SIM fields lower during summer due to surface melt water. I think reasonable estimates can still be obtained, but the lesser performance should be noted.

P5, L11: While the reference is provided, the uncertainty value is important and should be given explicitly here in the paper. A reader shouldn't' have to dig up a reference for what is salient information. And as noted above, summer uncertainties are higher.

P6, L10-11: What is the source for the DA index in terms of the data? I assume it's based on a reanalysis? That needs to be documented. Even if the values were provided directly by a colleague, the source that the colleague used needs to be cited.

P6, L13: Most importantly, SLP impacts winds and hence SIM.

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P8, L2: I find the color scale for Figure 4 somewhat ambiguous – it's hard to tell where the 0 anomaly is exactly and which small values are positive or negative. I would suggest perhaps a gradient two-color anomaly scale with white denoting 0.

P9, L11: Earlier in the paper (e.g., in the abstract), "yr" is used, but here "a" (I assume for "annum"). You should be consistent in usage, so choose one or the other (I prefer "yr", but "a" is perfectly acceptable).

P10, 3: For Figure 6, it might make things too busy looking, but I think it could be helpful to overlay the flux gates. Especially for January, it's hard to tell if the vectors are advecting ice across the Pacific gate or not.

P11, L2: What are the "*"s next to the trends? I presume an indication of significance? That should be included in the caption.

P13, L4: The "summer season" should be defined here. It's noted further down on the page (June – September), but it should be specified when the term is first used.

P16, L10-14: I'm curious why AO shows such low correlation, but NAO shows higher. My understanding (which may not be complete or totally up-to-date) is that the two are very similar and that the NAO can be thought of as a regional expression of AO. Given that, I would've thought that AO would have higher correlation because it's hemisphere whereas the NAO is focused on the Atlantic sector. In other words, why would the Atlantic sector variability have much more effect on the Pacific sector than hemispheric variability?

P16, L23-25: This sentence is really difficult to follow. I'm not a big fan of the "positive (negative)" way of saying two things, but here it is especially tough because you use "positive (negative) NAO" for summer and then switch to "negative (positive) NAO" for winter. Trying to keep these straight is difficult! I would use "positive (negative) NAO" (or the reverse) for both cases and word the rest accordingly.

P17, L3: There is a lot of variability in yearly values, even when the correlation is fairly

high. Did you test for significance of the trends? I would guess that none of them may be significant. I think that would be good to include here and in the discussion.

P19, L23: Here again in Table 4, I'm curious about how different the NAO and AO correlations are. The differences are quite stark. In particularly, during the P4 period, the NAO and AO are even opposite signs. And while the AO has a higher correlation than the NAO through 2008, the NAO has had a much higher correlation since then. While earlier, you note that overall the AO correlation is weak and thus you focus on the NAO and DA, I think further discussion of the AO is warranted, particularly in terms of comparison with the NAO.

Technical Corrections

P4, L17: Use "length" instead of "distance".

P5, L28: typo, "does"

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