Comment on egusphere-2022-36
Pengfei Zhang (Referee)

Referee comment on "Impact of Atmospheric Rivers on Arctic Sea Ice Variations" by Linghan Li et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-36-RC1, 2022

Comments on TC manuscript egusphere-2022-36:

This manuscript investigates the impact of atmospheric rivers (ARs) on partial sea ice concentration variation based on observations. The authors started with two cases in the Chukchi Sea in the summers of 2012 and 2020. The surface heat fluxes when ARs approach the ice cover are analyzed. Then, the authors expanded their analysis to the partial sea ice cover in the whole Arctic.

General comments:

The research is interesting and within the scope of TC. However, I do have some major concerns (Note that this manuscript is revisable). First, the authors state previous literature which addresses results similar to what they are presenting. For general readers, it is hard to see how this manuscript is a significant scientific advance in knowledge. I do think that there are some novel insights in this work, but the novelty should be discussed in a more explicit way. Second, the case study is somehow superficial. I do believe this study could be much in-depth. I have some specific suggestions which may be helpful to improve this study (see details below). Overall, a major revision is needed to make the manuscript publication worthy on The Cryosphere.
Specific comments:

1. As mentioned above, several previous studies, such as Woods et al. (2016), Hegyi et al. (2018), and others discussed in the Introduction, have reported that the extreme water vapor transport, including ARs, can lead to the Arctic sea ice melt through the surface fluxes (radiative and turbulent) based on case study and statistical correlation analysis. These conclusions and the analysis method are generally similar to the current study. Therefore, I think the authors need to identify how this manuscript is unique from the existing studies, especially what gap of knowledge this manuscript addresses. To my understanding, most previous studies about the role of moisture transport in sea ice melt focused on the wintertime and the Atlantic sector; while the cases studied in the current paper occurred in the summer the Chukchi Sea. To distinguish from existing studies, the authors may confine their analysis to the summer. The surface energy balance in the summer Arctic is very different from winter, so I think focusing on summer (mainly on the Pacific side, including the Chukchi Sea) can be regarded as a novelty. Another suggestion to polish the novelties can be seen in #3.

2. Analysis method:

For the case study in Section 3.1, I suggest the authors present the daily anomalies (the departure from the daily climatology or the anomalies used in Section 3.2). Based on the analysis of original values of the surface energy fluxes, the authors argue that sensible heating is dominant. However, with the seasonal climatology in heat flux data, the conclusion might not hold. For example, given the climatological net longwave radiation in summer is negative (downward positive), the weak positive values shown in the figures may indicate a large positive anomaly. Therefore, using the original values cannot tell us which process is the dominant one. The current figures showing the original values can be moved to the supplementary file if the authors want to keep them. In addition, the authors may show how large the magnitude of the anomaly is (for example, exceeding its 1.5/2 standard deviation or not). In this case, Section 3.2.1 and Fig.5 can be removed to save space.

3. The role of dynamical ice motion, i.e., ice drifting due to the southerly wind associated with ARs, needs further analysis. For a specific location, such as the small box the authors chose, I agree that the wind anomaly could contribute to the local changes in partial sea ice concentration. Considering that ice drifting is regarded as one of the key conclusions in this study, the authors should clearly show the amount of ice drifting rather than the southerly wind only. The ice drifting has been discussed in many cyclone studies but
usually has been neglected in AR or extreme moisture transport studies (focusing on thermodynamical effects). Therefore, the analysis of ice drifting (if the evidence shows that it indeed matters) could be regarded as another highlight.

Technical

1. Rank correlation: I might miss some key information here, however, the authors may state how to rank the data. Does the result sensitive to the ranking?

2. Some figures should be refined. For example, it is hard for readers to identify the digits in Fig.1b&3b.

3. Figures 1a & 3a: The authors may clearly state how they define the SIC change during Aug 4-6, 2012.

4. Line 174: the details of the citation are needed. Is it obtained from an NSIDC webpage?

5. Line 208-209: More evidence is needed to support the argument “moisture content is more important than wind speed”.

6. Line 267-268: 15% is conventionally regarded as the edge of sea ice cover. I’m just wondering why the authors chose 85% as the upper limit. Is it an empirical choice? If so, the authors may remind the readers here and state that the conclusion is not sensitive to the choice after test.

7. Line 290-291: I’m wondering about the persistence of these events (say the continuous days exceed 1.5 or 2 sigma or 90% percentile). For example, if the mean persistence is 5-day, can we infer that the mean SIC melt per event is -5% at a given location? It would be great if the authors can add a figure to present the timescale of these events.

8. Line 295, 308-310: Most of the content of Section 3.2 is based on extreme moisture events. I fully understand that ARs and the 90% percentile moisture extremes share similarities and overlaps. Since the topic of this manuscript is AR, showing the analysis using AR (like Appendix Fig.3) would be more consistent, right?
9. Line 322-324: There are at least two effects of southerly wind associated with ARs: dynamically redistributing the ice fraction and transporting the water vapor into the Arctic. Thus, the authors may add “In addition to delivering water vapor into the Arctic” or similar words somewhere.